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THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

A POSSIBLE EXPANSION OF THE CGIAR

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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Alex F. McCalla
Chair

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Dr. Wilfried P. Thalwitz
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World Bank
1818 H Street, N.W.
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Dear Dr. Thalwitz,

I have pleasure in transmitting to you the report of TAC on a possible expansion of the CGIAR. This is the culmination of two years work on the assessment of the so-called non-associated centres and one and half years of study on Forestry. In this letter I attempt to guide you through the report and to highlight some of the key issues and major recommendations which require consideration by the CGIAR.

As a prelude to the examination of the subject matter areas represented by the non-associated centres and developing a proposal on the forestry and agroforestry initiative, TAC undertook an analysis of the need for, and the implications of, an expansion of the CGIAR. This is discussed in Chapter 2. The analysis focuses on the global context in which the CGIAR is likely to operate in the future. Particular attention is given to expected trends in world agriculture and forestry during the next two decades. The resulting challenges to agricultural development and resource management, and the implications for research in each of the major developing country regions (Asia and the Pacific, sub-Saharan Africa, Latin America and the Caribbean, and West Asia and North Africa) are discussed in Chapter 3.

The review of the Asia and Pacific region shows that agriculture plays a crucial role in employment and income generation and that rapid growth in food production is essential to keep pace with population increases. Research should emphasize development of cost reducing technologies to improve crop and resource management and promote nutrient use efficiency. For the longer term, it will be necessary to increase yield potential for the major cereals. The productivity of vegetables and livestock should also receive

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attention. Other areas considered for future research emphasis are aquaculture, integrated pest management, forest products and agroforestry.

The review of sub-Saharan Africa shows that potential for significant yield increases exists in all sectors. A clear need is identified for strong emphasis in research on resource management coupled with efforts to increase genetic adaptation to specific needs through improved crop, livestock and forestry productivity. Heavy emphasis on capacity building in NARS is needed to develop farmer-oriented technological innovations. Agricultural policies which offer incentives to farmers to intensify use of land and provide infrastructure for optimal use of inputs and marketing of outputs are required.

The review of Latin America and the Caribbean indicates that the adoption of existing technologies and known principles can contribute to the achievement of needed output in the region for the short to medium term. However, the generation of new knowledge and technologies is considered to be crucial in the longer term. Collaborative international strategic research is strongly advocated. Funding of NARS has recently taken a downward trend due to the financial situation of many countries in the region. Therefore, increased and urgent attention is needed in priority setting and on organization and management of research at national and regional levels.

With respect to the West Asia and North Africa (WANA) region, TAC considers that it is unlikely that the expected increase in forestry and fishery productivity will be adequate to enable the region to become self-sufficient in food and forestry products. However, trade opportunities will allow most WANA countries to achieve food security and self-reliance. Future agricultural and forestry research in the WANA region should be geared primarily to activities that enhance income generation and to commodities that meet the needs of the growing urban population.

The evolving needs for international agricultural, fisheries and forestry research and their implications for CGIAR priorities and strategies are discussed in Chapter 4. This Chapter clarifies the special nature of international research; discusses the scientific capacity of NARS in developing countries; provides an overview of international and regional scientific capacity in developing countries; and finally draws together an inventory of perceived needs for international strategic research in agriculture, fisheries and forestry. Illustrative examples of potential research activities are outlined under nine research categories.

Chapter 5 provides an overview of the evolution of the CGIAR including the rationale for its current structure, and a historical evolution of CGIAR priorities. It also assesses the main strengths and weaknesses of the current organizational structure of the CGIAR.

The process of analyses and criteria used for the evaluation of the subject matter and institutions represented by the non-associated centres as well as for the review of strategy and options for forestry in the CGIAR System are outlined in Chapter 6. This chapter also refers to the extensive background documents prepared and used by TAC in its deliberations. As you will recall, the process and criteria were discussed and endorsed by the Group at its Mid-Term Meeting in The Hague in May 1990.

In Chapter 7, TAC re-examines the current goal of the CGIAR in light of the proposed expansion and concludes that there are compelling reasons for redefining the goal and expanding the objectives of the CGIAR. As a result, a revised Mission Statement is proposed to replace the current CGIAR goal statement.

The objectives associated with the current CGIAR goal have also been revised and redesignated as goals. Consequently, what is presently defined as CGIAR goal and objectives will become CGIAR mission and goals. The new Mission Statement introduces the notion of food self-reliance as opposed to the current implicit emphasis on national food self-sufficiency. A framework consisting of nine goals to which research activities contribute is proposed for the systematic analysis of priorities in the CGIAR. This framework includes improved productivity of fisheries and forestry as additional new goals. The Group may wish to consider and endorse the revision of the CGIAR mission and goals as these are used extensively in the evaluation of future activities.

Before making specific decisions about the non-associated centres, and forestry and agroforestry, TAC felt it necessary to have a medium- and long-term conceptualization (vision) of how the CGIAR could evolve in the future. This is presented in Chapter 8. This vision depends on the necessary strengthening of NARS with consequent changes in the size, activities and role of the CGIAR. In the long term TAC sees the CGIAR with a more limited role in highly focused global activities of a strategic nature. In the medium term, in addition to global activities, TAC sees increasing effort on research focused on agroecological zones, regionally defined. For these, TAC has coined the term "ecoregional". Given that these two concepts--global and ecoregional activities/institutions--play important parts in TAC analysis and conclusions, they are also discussed fully in this chapter.

Chapter 9 presents the evaluation of subject matter areas and non-associated centres. The analysis starts with what TAC perceives to be the future role of the CGIAR in the subject matter areas and the extent to which these evolving needs are already being met by the CGIAR, non-associated centres, and other institutions. Based on the criteria adopted by TAC, all but one subject areas represented by the non-associated centres (fertilizer technology) were considered

appropriate for CGIAR support. TAC then examined the characteristics of each non-associated centre. For those non-associated centres where some activities qualified for inclusion in the CGIAR, institutional options were considered.

On the basis of TAC's assessment AVRDC, ICLARM and IIMI are recommended for inclusion in the CGIAR subject to certain conditions being fulfilled by their Boards and management. TAC is recommending that the CGIAR should continue to support research on banana and plantain through IITA which already has plantains in its mandate. INIBAP would become an integral but distinct component of IITA's Banana and Plantain Programme. ICRAF in its present form as a stand-alone institute was not recommended for admission into the CGIAR. However, a modified ICRAF could play an important role in the proposed CGIAR forestry and agroforestry initiative. CGIAR support for the activities of IUFRO/SPDC could be done within the context of the CGIAR programme on forestry and agroforestry. With respect to ICIPE, IBSRAM and IFDC, TAC recognized that these institutions play important roles in the global agricultural scene but using the criteria adopted they did not qualify for inclusion into CGIAR. TAC sees however a need for increased and coordinated efforts among CGIAR centres on soils, crop protection and plant nutrition. Pending the outcome of a study by Winrock International on livestock in sub-Saharan Africa, TAC has made only an interim recommendation on ITC and on the ticks and tsetse programmes of ICIPE.

In its 1985 Review of CGIAR Priorities and Strategies, TAC recommended coconut as a new initiative for CGIAR support along with aquaculture and vegetables. The CGIAR endorsed the recommendations and asked TAC to develop appropriate proposals. In this analysis TAC has reviewed a possible role for the CGIAR in coconut research and has recommended that it should be included among the portfolio of activities to be supported under the CGIAR forestry and agroforestry initiative, with immediate development of a germplasm activity through IBPGR.

Chapter 10 considers the strategy and institutional options for incorporation of forestry and agroforestry into the CGIAR. In particular it provides a background on the events and trends which led to the CGIAR introducing forestry and agroforestry research into its mandate; summarizes TAC's conclusions on CGIAR support for certain aspects of forestry and agroforestry research; explores institutional options to achieve the task; and provides TAC's assessment of the most desirable course of action for the CGIAR. Based on its analysis and evaluation, TAC concludes that the most effective way of dealing with priority forestry and "trees in land use" issues of concern within the CGIAR mission is to develop an integrated forestry/agroforestry approach. It considers that such an approach would be more effective in addressing the underlying causes of tropical deforestation than establishing separate forestry and agroforestry centres, since the problems associated with deforestation can only be addressed

effectively with an approach that involves close interaction between agriculture, agroforestry and forestry.

The approach recommended by TAC gives strong emphasis to support for meeting regional and national needs through: a coherent plan to build on the capability of existing CGIAR centres; and contractual and collaborative arrangements with regional and national research institutions. It also provides for global strategic research efforts through: the incorporation of forestry/agroforestry activities into the mandates of IBPGR, IFPRI and ISNAR; and the establishment of an integrated forestry/agroforestry research centre to serve as a central focal point for forestry and agroforestry research in the CGIAR.

Finally, TAC examines the implications of its findings and recommendations on the future structure and financial requirements of the CGIAR System. It recognizes that if its recommendations are endorsed by the Group they will have significant consequences for the overall structure of the CGIAR, the mandates of the current centres as well as the additional entities and financial resources. These issues are discussed in Chapter 11. A possible evolutionary path for the CGIAR is presented, followed by a general discussion on possible options for restructuring and funding scenarios. TAC has purposely refrained from making explicit recommendations on the future structure and size of the CGIAR System at this stage. However, it hopes that it has succeeded in promoting the necessary dialogue among CGIAR members.

Mr. Chairman, in transmitting this report, TAC completes the analysis of these issues as requested and on time. I am pleased that the analysis is careful, comprehensive, and I believe objective and balanced. The accomplishment owes an enormous debt to TAC members, the TAC and CGIAR Secretariats and the many external consultants who have worked so hard. I also acknowledge the valuable cooperation and help we have received from FAO. I trust the report will provide you and the group with the necessary information to make what we consider to be crucial decisions for the long-term future of the CGIAR.

Yours sincerely,

Alex F. McCalla
TAC Chair

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A POSSIBLE EXPANSION OF THE CGIAR

CHAPTER 1 - INTRODUCTION

This report presents TAC's recommendations on the possible expansion of the CGIAR. It was prepared in response to a request to TAC from the CGIAR to consider adding ten non-associated centres and forestry and agroforestry to the CGIAR System. As a background to the decisions, the report analyzes the current and future situation in various regions of the developing world and the unique contribution which international research can make. The report also presents TAC's vision of the future before making a series of specific recommendations on the inclusion in the CGIAR of research on forestry and agroforestry and of a number of the non-associated centres. TAC's analysis and recommendations also have implications for existing CGIAR institutions and the future structure of the CGIAR. These implications and some options are discussed. Finally, the financial resource needs of an expanded CGIAR are explored.

The Consultative Group on International Agricultural Research (CGIAR) has, since its inception in 1971, been a dynamic system. It is regularly reviewing its priorities and strategies, and is adjusting to the evolving demands of a changing global environment. During its first decade of activity, the number of international agricultural research centres supported by the CGIAR increased from the initial four to thirteen. The scope of activities expanded also. CGIAR Centres are concerned with the science and technology of food production, the policy framework for agricultural development, and the organization of national research systems. The First Review of the CGIAR in 1976 recommended a period of consolidation and the Second Review in 1981 called for a moratorium on the number of Centres, with new activities to be incorporated into the existing framework.

TAC's most recent Review of CGIAR Priorities and Strategies which was approved by the CGIAR in 1986 (TAC/CGIAR, 1987) and the CGIAR Impact Study (Anderson et al., 1985) identified a number of issues requiring further explicit evaluation. These included sustainability, resource management and environmental degradation; income generation, employment and equity; evolving partnerships with national agricultural research programmes; the need to move towards strategic research; and slow rates of food production increases in less-favoured environments. The Priority and Strategies paper further recommended that the commodity coverage of the CGIAR be expanded to include vegetables, coconuts and aquaculture. In addition, over recent years a number of new entities, patterned after CGIAR institutes and supported by many of the same donors, have been established outside the CGIAR. These entities undertake research either on commodities currently outside the scope of the CGIAR (such as vegetables, fisheries and forestry), or on resource use and management that reinforces work of the CGIAR (such as soil management, irrigation and agroforestry). This has raised the question whether the CGIAR "should be broad and inclusive rather than selective and exclusive" (CGIAR Chairman, Berlin, 1988).

At its Mid-Term Meeting in Berlin in May 1988, members of the CGIAR discussed the work currently being undertaken by the new entities,

i.e. the so-called "non-associated centres", and asked TAC to undertake an examination of a possible expansion of the CGIAR. The institutions were, in alphabetical order: AVRDC, IBSRAM, ICIPE, ICLARM, ICRAF, IFDC, IIMI, INIBAP, ITC and IUFRO/SPDC. At the Mid-Term Meeting in Canberra in May 1989, CGIAR members agreed on a "Declaration of Intent on the Future Work of the CGIAR" in which they stressed "the evident and urgent need to investigate the significant research issues of natural resource management for sustained food production and for the long-term maintenance of lands best suited to tropical and subtropical forests". Accordingly, CGIAR members declared their intention to continue to give emphasis to the CGIAR mandate of research on sustainable food production and "to expand this emphasis to include research on the optimal management of tropical and subtropical forest lands giving particular stress to the interaction of agriculture and forestry, and the use of forest resources as an important contributor to the rural economies, energy needs and the wealth of partner nations" (CGIAR Secretariat, 1989, Annex I).

In undertaking its task of examining a possible expansion of the CGIAR, the Committee decided it would be necessary to reconsider:

(i) the CGIAR in its global context;

(ii) the scope of CGIAR support for research and related activities, and priorities for existing as well as possible new areas of subject matter coverage;

(iii) the mandates, research goals and priorities of potential new institutions as well as existing ones;

(iv) organizational modes and structures; and

(v) any other matters relevant to a comprehensive analysis of the future of a potentially expanded CGIAR.

As this process has proceeded TAC has approached the re-evaluation of the CGIAR in an iterative fashion. First, TAC evaluated potential global macro needs to the year 2025 to determine the broad parameters that should guide international agricultural research in the CGIAR, recognizing that the CGIAR was a relatively small part of the overall global research establishment. In particular, TAC addressed questions of sustainable production systems on the full spectrum from mono crop annual cropping systems through mixed cropping/livestock/tree systems (agroforestry), natural forest resource management including the management of biodiversity, to commercial forestry activities. These analyses were initiated first at a regional level and then integrated globally. Finally TAC critically evaluated the CGIAR as it has evolved to date.

The second step began with fact-finding activities regarding the specific entities (non-associated centres) in terms of the role they played in specific subject-matter areas (micro analysis). After these first two steps, TAC has iterated between global macro evaluation and micro subject matter evaluation which, after initial reviews of the non-associated centres (NAC), was broadened to include both NACs as well as existing CGIAR institutes.

At TAC 51 (March 1990) TAC was presented with the recommendations of a number of subject matter panels (banana and plantain, livestock

disease in sub-Saharan Africa, fisheries/aquaculture, natural resource management, forestry, crop protection and interfaces with national programmes). An eighth panel's recommendation on vegetables was received at TAC 52 (June 1990). TAC acted in a tentative fashion on each of the panel's recommendations and initiated broad discussions of the implications for the long-term structure of the CGIAR of accepting these recommendations. As an interim step in the analysis a draft options paper provided a more concrete set of proposals to discuss. TAC finalized its analysis and formulated recommended options at its meetings in June and August of 1990. This report presents the results of that analysis. Special attention has been given to forestry and agroforestry.

The report starts with the background and process of the analysis (Chapters 2 to 7). These chapters review evolving global trends and analyses regional challenges and opportunities. The needs for international research and the evolution of the CGIAR are then discussed. Next comes a description of the process followed in the analysis, the criteria for CGIAR support, and a revised CGIAR mission and goals statement.

Chapter 8 examines what appear to be the emerging long- and medium-term trends. It presents TAC's vision of the future of the CGIAR and its conceptual notions of commodity and ecoregional activities.

The evaluation of subject-matter areas and non-associated centres is considered in Chapter 9. This chapter reviews future CGIAR research needs in the subject matter areas represented by the non-associated centres; analyzes selectively current activities in the CGIAR, non-associated centres, and national systems; reviews the characteristics of the non-associated centres; discusses where appropriate, institutional options; then presents TAC's recommendation on the inclusion or otherwise of these centres into the CGIAR.

The strategy and options for inclusion of forestry and agroforestry in the CGIAR are considered in Chapter 10. This chapter outlines the priority areas for forestry and agroforestry, considers institutional options for research in this area and presents TAC's recommendations for the creation of an integrated forestry/agroforestry research centre.

Finally, the structural and resource implications of the analysis and recommendations are reviewed in Chapter 11 and issues are raised for the consideration of the CGIAR.

From the outset of the process, TAC has taken the position that specific decisions should be taken in a broad and futuristic context. This explains the length and complexity of the report. TAC felt the report should be comprehensive and self-contained, and present the basic information TAC used in its analysis. For many CGIAR members the early parts of the report will seem familiar. The discussion of mission and goals (Chapter 7) was part of the TAC Chairman's proposed approach presented at ICW 88. The basic materials in Chapters 2, 3 and 4 were discussed at ICW 89 and the process and criteria used (Chapter 6) was discussed at the CGIAR Mid-Term meeting in May 1990. The substance of TAC's analysis and its basic conclusions are new and are presented in an integrated fashion in Chapters 8, 9, 10 and 11.

CHAPTER 2 - EVOLVING GLOBAL TRENDS

2.1. Factors Affecting Food Demand

During the next three decades, the demand for food in developing countries will be affected by three major factors: population growth, income growth and urbanization.

According to the medium variant estimates of the United Nations (United Nations, 1988), the total population of the developing countries is projected to grow progressively from 3.6 billion in 1985, to 4.9 billion in 2000, to 5.8 billion in 2010 and to 7.0 billion in 2025. The present growth rate is about 2.1% p.a., but the slowdown in population growth that started in the early seventies is projected to continue, so that the annual growth rate will decline to 1.9% by 2000 and fall to 1.1% by 2025. While at present about three quarters of the world population lives in developing countries, this proportion will increase to 79% in 2000, to 81% in 2010, and to 83% in 2025 (Table 2.1.).

Table 2.1. Population Size and Percentage Distribution for the World, Developed and Developing Countries and Major Geographic Areas, Medium Variant Case, 1960-2025

	World	Dvlp'd	Dvlp'ng	SSA	Lat.Am.	Asia/Pac.	WANA
			POPULATION (MILLIONS)				
1960	3019	964	2055	209	218	1505	123
1970	3697	1074	2623	270	285	1906	162
1985	4855	1210	3645	421	404	2575	245
2000	6251	1311	4940	678	540	3349	373
2010	7191	1365	5826	916	631	3810	469
2025	8467	1422	7045	1296	761	4379	609
			DISTRIBUTION (PERCENTAGE)				
1960	100.0	31.9	68.1	6.9	7.2	49.8	4.1
1970	100.0	29.1	70.9	7.3	7.7	51.5	4.4
1985	100.0	24.9	75.1	8.7	8.3	53.0	5.0
2000	100.0	21.0	79.0	10.8	8.6	53.6	6.0
2010	100.0	19.0	81.0	12.7	8.8	53.0	6.5
2025	100.0	16.8	83.2	15.3	9.0	51.7	7.2

SSA = Sub-Saharan Africa
WANA = West Asia/North Africa
Lat. Am. = Latin America and the Caribbean
Asia/Pac. = Asia and the Pacific

Source: United Nations (1988)

Population growth rates in developing countries are in general well above those of developed countries. Wide regional differences can be observed, with the highest rates expected in sub-Saharan Africa, and the lowest in Asia; however Asia's population increases will be the largest in absolute terms. The continent already contains 53% of the world's population, although this share may not increase further because of the effects of family planning in China and India. The population of Africa south of the Sahara is expected to expand threefold between 1985 and 2025, thereby increasing its share in the world population from 8.7% to more than 15%. The growth rate is particularly high in Eastern and Southern Africa. In Latin America, the population will increase by approximately 100 million every decade and in West Asia/North Africa the population is also growing fast.

Income growth is a significant factor in determining food demand, in both size and composition. In addition to an increase in food consumption, the general trend is for diets to shift from staple grains to more livestock products and vegetables. Increases in demand for livestock products in turn lead to an expansion of demand for freed grains. For the next ten years, the World Bank has projected an annual growth rate in per caput income of 2.0% in developing countries as a group, but no growth is expected for sub-Saharan Africa.

On a global basis, there are positive indications about future income growth. FAO is cautiously optimistic about future economic growth until the year 2000, while IFPRI expects the decade of the nineties to be a period of renewed strong economic performance (FAO, 1987; Mellor, 1988). It is likely that actual income growth will be determined largely by political events, the future of oil prices, and national economic and trade policies.

Urbanization is also a major factor determining food demand, particularly its composition. Urban consumers will make further shifts in their diets from coarse grains, roots and tubers to high-value cereals (such as wheat and rice) and livestock products. Urbanization also affects the mode of food supply, more of which has to be generated through production for markets rather than through subsistence agriculture. At present, approximately 31% of the population of developing countries live in urban areas, although there are strong regional differences. In Latin America, 69% of the population is urbanized, the proportion being particularly high in the subtropical and temperate zone countries. In sub-Saharan Africa, 28% live in urban areas and in North Africa 47%. Asia is the least urbanized continent, as only 25% of the population live in urban areas. In South Asia, the percentage amounts to only 12%. By the year 2000, about 40% of the population in developing countries will be living in towns and cities, and by the year 2025, the urban population will be 57% of the total (United Nations, 1987).

In addition to population growth, the strong trend to urbanization is further reducing the area of land for food production as cities and villages sprawl outwards. Urbanization is also causing pollution of areas used for intensive production of vegetables and other food crops. Industrial and urban wastes also pollute waterways and groundwater affecting fisheries and drinking water.

2.2. Malnutrition and Poverty

Malnutrition remains a common feature throughout the developing world. Many people simply do not have enough food to eat, and the well-being of even larger numbers is diminished because their food is of poor quality and lacks diversity.

About half a billion people are believed to be at nutritional risk because they have limited access to a basic diet. As the nutritional status of representative populations has only rarely been measured, this estimate of the prevalence of undernourishment is based on the dietary energy supply (DES) of nations together with other factors, such as income, that affect its distribution. People are judged to be at risk if the energy available for consumption is less than 1.4 times the basal metabolic rate, or about 1,500 kcal/caput/day. Intakes at or below that level are not sufficient to support even moderate physical activity of adults and childhood growth is limited. In the early 1980s, nearly one-third of the people with incomes less than US$ 400 a year, excluding China, were in the risk category. In Africa and the Far East, 25-26% of people are at risk, in Latin America 16% and the Near East 12% (FAO, 1985).

Despite the projected improvements of consumption levels in developing countries, the number of malnourished people is expected to rise further. The number of people with consumption levels below the critical threshold value is likely to increase from the present 510 million, to 630 million in 2000 although, as a percentage of the total population, their relative number may decline (FAO, 1987).

Limitation of food variety and quality, as well as seasonal variation in intake, results in deficiencies of vitamins and minerals. The most widely recognized deficiencies involve vitamin A, iron and iodine. Inadequate consumption of specific foods or food groups is also the root cause of other persistent but less common deficiency diseases, such as scurvy (lack of vitamin C) and pellagra (lack of certain of the B vitamins). Regionally important deficiencies of other nutrients are known (such as zinc and selenium) and the list is likely to grow as better methods of identification are developed.

Anaemia is the most prevalent nutrition-related disease. An estimated 800-900 million people are affected. These are mainly from developing countries, where the condition is common among children below the age of 12 and among pregnant women.

It is clear that the prospect of chronic food deprivation for a large number of people cannot be averted by increased food production alone. Deficiency of vitamins and minerals persists even though potentially effective intervention strategies have been developed by the health sector. A broader range of agricultural development strategies is needed coupled with domestic economic growth and more equitable distribution of the benefits. Furthermore, pollution of foods with heavy metals and other chemicals should be carefully monitored and preventive action taken where necessary.

Strategies to improve nutrition and alleviate hunger should focus not only on improving food supplies, but also on ensuring access to food by the poor, by increasing their purchasing power. People are often malnourished because they are too poor to buy available food. A recent

report from the World Bank defined poverty as the inability to attain a minimum standard of living (World Bank, 1990). Poverty has many dimensions including inadequate incomes, malnutrition, lack of access to social services, and lack of social and political status. On the basis of indices that reflect minimum level of consumption and standard of living, the report has estimated that 1.1 billion people, or 33% of the population of developing countries live in poverty. About three-quarters of these poor, 800 million people, live in Asia, namely in India, Bangladesh and China. In sub-Saharan Africa, the number of poor amounted to 180 million people, while an additional 70 million poor live in Latin America, 60 million in WANA and 6 million in the developing countries of Eastern Europe. Although the report highlights progress made in reducing poverty during the last 25 years, it also points to the slow rate of progress during the 1980s.

Efforts to increase food production should be accompanied by policies to expand employment opportunities and income generation. An employment-orientated development strategy normally requires rapid growth in food production and declining food prices. These can occur simultaneously through technological change in agriculture which increases labour productivity and reduces cost of production per unit of output (Mellor, 1984 and 1987).

Accelerated agricultural growth through production-increasing technological change generates capital and creates demand for goods and services that can be efficiently produced by other sectors of the economy with low capital-to-labour ratios. IFPRI research has shown that, in Asia, small farmers spend 40% of income increments on locally produced non-agricultural goods and services, and about 20% on horticultural and livestock products, which are also labour-intensive to produce. This link between agricultural growth and labour-intensive growth needs to be encouraged.

To do so would require greater attention by governments to infrastructure development, which may provide the link between amelioration of poverty in the short term, and a self-reliant removal of poverty in the long term (Mellor, 1988). Particular attention should also be given to the development of appropriate livestock technology to meet rapidly growing demand as incomes rise. Smallholder livestock production usually creates jobs. Production of fruit and vegetables is also likely to generate rural employment as incomes rise.

2.3. Population Supporting Capacities

Since the beginning of the 1970s there have been various estimates of agroecological potentials of land, and their population-supporting capacities in relation to climate, soils, crop species and variety, level of inputs, and rate of bringing new land into production (Buringh et al., 1975; FAO, 1982 and 1984).

FAO's estimates indicate that by the year 2000, for the developing world as a whole, the food situation, if low external input farming methods were to continue, would be critical. The entire potentially cultivable rainfed land in the developing countries, more than three times the present cultivated area, could support only 1.6 times the expected population, leaving little margin for non-food crops or for population growth after the year 2000. Such an area expansion of

agriculture, if possible at all at the required rate, would have negative consequences for forests and other natural ecosystems. Moreover, it should be realized that a large proportion of the extra potential arable land is located in two countries only: Zaire and Brazil.

With intermediate inputs (some fertilizers, conservation measures, etc.) theoretically four times the year 2000 population could be supported (FAO, 1982). Thus, in theory, with the application of higher levels of external inputs, improved husbandry and the use of all rainfed land resources for food production, the developing countries as a whole would be able to produce enough food. This is a far too optimistic view as this global result masks the prospects for individual countries. The country results of the FAO study give considerable cause for concern: Southwest Asia is the region where rainfed land resources are most inadequate to meet the food needs of future populations, while the largest absolute number of people affected by potentially critical shortages of land is in Southeast Asia. Given the low level of use of external inputs, prospects for food security in sub-Saharan Africa seem most clouded.

The technical options in Latin America appear to be far the most numerous. Theoretically, the potential capacity for Latin America far exceeds its own projected food needs, while maintaining considerable areas of natural forest. However the situation in Central America and the Caribbean is much more restrictive.

The food situation in Africa south of the Sahara is critical at present, but technically, the long-term prospects are reasonably good. Only an intermediate level of inputs on part of the potentially cultivable land would be needed to feed the population for several decades to come. Except for a few countries, the potential contribution of irrigation is small. However, natural resources are unevenly distributed with Central African countries favourably placed, while many countries in the Sahel and Eastern Africa are in a much worse situation, the more so because some of these countries have few non-agricultural resources on which to base their international trade.

Asia and the Pacific region have done well in the past decades, but the situation may become critical within a generation. In due course this will call for considerable expansion of irrigation and structural improvement of existing irrigation systems. There is also scope for similar improvement in rainfed, wetland rice environments (bunded rice).

Many countries in the arid West Asia/North Africa region are facing the situation that even if they were to make full use of their land potentials, they would be unable to produce all of their own food. However, a number of these countries are oil producing and others are increasing their self-reliance by diversifying their economies and exporting labour.

This qualitative overview of resources for food production shows that there are still many options to solve the food problem, but that the challenges to agricultural development and sustainable resource management are very diverse, with similarly diverse implications for agricultural research in the major developing regions.

2.4. Future Demand and Supply Balances

The demand for agricultural products for all food and non-food uses in the developing countries is projected to grow at 3.1% p.a. over the period 1983/85-2000 (FAO, 1987). This is lower than the 3.7% growth rate achieved between 1970 and 1985. The slowdown in the growth of total demand is caused by the lower growth rates of population and the already relatively high consumption levels in some middle-income countries, particularly in Asia and the Near East. In sub-Saharan Africa, per caput consumption will remain low and largely depend on subsistence production and low-cost food imports, including food aid. Inadequate access to food is another major factor inhibiting demand for food over the next three decades. Because of the poor state of the economy of many developing countries, aggravated by the debt crisis and the lack of foreign exchange, growth in consumption will often depend on the development of the domestic agricultural sector.

Although total agricultural production will continue to increase in most developing countries, there will be little improvement on a per caput basis. The projected growth rate of gross aggregate production to the year 2000 is 3% per annum, which is below the 3.3% achieved during the last 15 years. On a per caput basis, the growth rate would amount to 1.1% p.a. Most of the production growth would be due to increases in yields as a result of irrigation, improved seed varieties and higher input levels. During the next decade, FAO expects an expansion of arable land of only 0.6% p.a., although harvested area would increase by 1% p.a. due to an increase of cropping intensity. The overall agricultural self-sufficiency ratio of developing countries, which fell from 106% in 1969/71 to 101% in 1983/85, would further decline to just under 100% by the year 2000 (FAO, ibid).

The broad trends in growth of demand and supply in developing countries by geographic region is presented in Table 2.2.

Table 2.2. Growth Rates of Total Demand for Agricultural Products and of Total Agricultural Production in Developing Countries (1961-2000, % Per Annum)

	1971-70		1970-85		1983/85-2000	
	Dem.	Prod.	Dem.	Prod.	Dem.	Prod.
All Developing Countries	3.6	3.5	3.7	3.3	3.1	3.0
Sub-Saharan Africa	3.1	2.8	2.9	1.7	3.5	3.1
Asia	3.6	3.8	3.7	3.7	3.1	3.0
Latin America	3.6	3.0	3.2	3.1	2.7	2.6
West Asia/North Africa	3.4	3.0	4.9	2.9	3.1	3.1

Source: FAO (1987)

In sub-Saharan Africa and Asia, and among large segments of the population elsewhere, malnutrition will persist at least during the next thirty years. Low-income countries, particularly those that already have very low food availability per caput, are expected to make little progress. If present trends continue, malnutrition and poverty will remain a common attribute for the majority of people in sub-Saharan Africa and South Asia. As already indicated in Section 2.2., strategies to improve nutrition and alleviate poverty should focus not only on increasing food production but also on ensuring access to food by the poor by improving their purchasing power. Achieving self-sufficiency in food production should not be an end in itself. Agricultural development should be seen in a broader perspective and attention given to its importance for employment and income generation and for encouraging trade. Countries with no comparative advantage in producing food staples could diversify their agricultural sectors to encourage production of cash crops. This would also generate foreign exchange.

2.5. Trade Patterns

Despite significant increases in food production in developing countries, there has been a rapid growth in reliance on international trade to supply food. Whereas developing countries (excluding China) in 1961/63 imported only 5% of their food needs, this percentage had risen to 10% in 1983/85. During the same period, developing countries turned from being net exporters to net importers of food in terms of calories (FAO, 1987). The self-sufficiency ratio of agricultural production declined sharply in Africa and the Near East, only slightly in Latin America, and remained constant in Asia.

Imports of cereals have been growing particularly rapidly, tripling in 25 years. The increase occurred particularly during the last decade, and by the mid-1980s grain imports by developing countries represented 46% of the world's total, up from 36% in the 1960s. Growth rates of cereal imports were particularly rapid for coarse grains (especially maize) reflecting their expanding use for animal feed, as consumption patterns shifted towards more animal products, especially in middle-income developing countries.

Exports from developing countries have grown only sluggishly and, in most, the net agricultural trade surplus has deteriorated. Demand from high income countries for the traditional agricultural export commodities of developing countries in some instances is expected to grow only very slowly.

During the last 20 years, international economic conditions and national trade policies have become of significant importance to agricultural development in the third world. The debt crisis, fluctuations in exchange rates, economic recession, and volatile oil and commodity markets have strongly affected developing countries, particularly those with a high dependence on agricultural exports. International agricultural trade is in disarray. Most industrial countries have agricultural trade policies to complement domestic support policies designed to redistribute income to agriculture, to keep small farmers operating and to contribute to other domestic objectives. In Western countries, this has contributed to surplus production, the growth of subsidized exports of agricultural products, and dumping practices. For developing countries, this has led to a deterioration of terms of trade and aggravation of economic hardship.

Developing countries would benefit from policy adjustments in developed economies that would reduce surplus production of cereals and livestock products, and encourage imports of third world agricultural products. This would help to reverse the trend of the declining net agricultural trade balance of developing countries. The outcome of ongoing multilateral negotiations particularly, for example, the GATT/Uruguay Round, will therefore be of primary importance to the development of agricultural trade.

2.6. Sustainability of Agricultural Production

Concern about the widespread depletion of the natural resource base for agricultural production has grown over the past two decades. Problems such as loss of genetic diversity, depletion of water resources, soil erosion, salinization, waterlogging, desertification, deforestation and environmental pollution threaten the sustainability of agriculture in large areas of the developing world. Agricultural activities can have negative environmental consequences on other sectors such as fisheries. Efforts to increase agricultural production substantially in coming decades to meet population growth will accelerate these problems unless new strategies are formulated and adopted. An added dimension to be considered is the uncertainty introduced by prospects of global climate change which could further compound the problems.

It is important to recognize that, within certain limits, sustainability and increased production are compatible goals. Increased production on existing agricultural land reduces the pressure to clear and develop new lands. In the past, much of the incremental agricultural production has come from irrigated areas. Furthermore, intensive production systems can be managed to enhance land quality and reduce soil erosion by providing abundant vegetation to keep the soil covered and by maintaining nutrient and organic matter levels in the soil. Therefore, as in the past, high priority should be given to research designed to increase yields. However, the past neglect of research on the conservation and management of natural resources must be addressed and higher priority given to both technical and socioeconomic aspects of sustainability.

More effective ways in which international agricultural research should address the issues of sustainability and environmental hazards were outlined in a recent TAC report (TAC/CGIAR, 1988) which emphasized the need for all agricultural research to have a sustainability perspective. Furthermore, greater research emphasis on the problems of less-endowed regions is needed. These areas are marginal and therefore fragile but, in many countries are especially subject to increased exploitation due to population pressure on arable land resources. The research needed for these areas should be grounded in an understanding of the existing production systems.

The level of external inputs used by farmers is a key factor determining sustainability. In less-endowed regions, systems using no external inputs eventually deplete soil nutrient reserves, reduce vegetative cover and leave soil exposed to degradation. In areas where farmers cannot afford, or have limited access to external inputs, the adoption of systems with low levels of purchased external inputs based on nutrient recycling, particularly organic manure, biological

nitrogen fixation, and/or agroforestry will sustain a moderate level of production and limit degradation. However, in better endowed areas high levels of external inputs are necessary to sustain high levels of production without depleting soil fertility. The key to sustainability in these areas is the efficient use of inputs, especially considering that environmental pollution and economic loss serious consequences of the inefficient use of chemical inputs.

Amongst the various regions, Asia has serious environmental problems resulting from population pressure on land resources and from deforestation which, in upland watersheds, is causing soil erosion. In the Near East and North Africa, soil erosion and salinization are major problems. Soil fertility depletion, soil erosion, desertification caused by overgrazing, and deforestation due to fuelwood harvesting are widespread in sub-Saharan Africa. Deforestation is a serious problem in Latin America mainly due to government-sponsored and private programmes of settlement for agricultural and livestock production.

Recent estimates put the rate of deforestation in the tropics at 17 million ha or 1% per annum (TFAP, 1990), although it should be recognized that this is a tentative estimate which includes deforestation caused by shifting cultivation, a traditional labour intensive system for farming forest areas. Practiced at low intensity, shifting cultivation can be sustainable but population growth has led to a shortening of the bush fallow period. Often, there is a pernicious link between logging, shifting cultivation and extensive grazing. Loggers open roads into the forest and although they only take out a few trees, this facilitates total clearing by shifting agriculturalists. When these abandon the area, large cattle estates establish pastures for extensive, often unsustainable, animal husbandry. Fires, fuelwood collection, settlements for agriculture, logging for timber and industrial use of forests are the other main causes of the depletion of tropical forest resources. The deforestation leads to loss of genetic diversity and extinction of some species, invasion of pernicious weeds such as Imperata, which is widespread, and land degradation. Off-site effects include flooding, siltation and salinization, caused by disturbances to groundwater hydrology. The silt damages fisheries as well as infrastructure such as hydropower, irrigation and water supply schemes.

In arid and semi-arid areas, aridification is aggravated by overstocking, over-exploitation and fuelwood collection and may lead, in the long term, to desertification. Low and erratic rainfall slows the regeneration of native fodder trees. The importance of the lack of fuel is indicated by the FAO estimate that 100 million people live in situations of acute fuelwood scarcity (FAO, 1983).

Some deforestation is inevitable as agriculture expands to meet increased demand for food. Such expansion should not take place on marginal land where sustainability of agricultural production is at risk. Research is needed on socioeconomic issues, such as land tenure, as well as on the agricultural and forestry technologies appropriate to overcome the problems in various agroecological zones.

Another major concern of global significance is the problem of climatic changes which may occur due to changes in the composition of the atmosphere. Intensive international efforts are currently underway to reduce scientific uncertainties regarding the magnitude, timing, and

regional impacts of global climate change. It appears that in some regions agricultural production will benefit whereas other areas will be at risk caused by decreases in soil water during the growing season. Better definition of the impacts in different agroecological zones, consideration of the need for varietal adaptation through breeding programmes and quantification of the sources of greenhouse gases in the tropics are some examples of the topics requiring research. Since the climatic changes may have an impact on the food situation, particularly in developing countries, it is essential that agricultural research strategists closely monitor and take into account developments in knowledge of the greenhouse effect.

CHAPTER 3 - REGIONAL CHALLENGES AND OPPORTUNITIES

3.1. Introduction

Chapter 2 broadly examined global trends in food [illegible] and supply, malnutrition and poverty, and the depletion of nat[illegible] resources. This chapter takes a regional perspective and looks more particularly at trends in each of the four developing country regions, namely the Asia and Pacific region, sub-Saharan Africa, Latin America and the Caribbean region, and West Asia and North Africa (WANA).

The following sections provide an overview of the challenges to agricultural development and resource management, and the resulting implications for research, in each of these regions. The information presented in this chapter has been drawn from three main sources:

- the continuing accumulation of knowledge in the CGIAR Centres from their worldwide activities and contacts with national agricultural researchers and policy makers;
- the outputs of the international task force set up to identify the needs of a global research effort on tropical forests, woodlands and upland watersheds; and,
- the very considerable efforts of FAO in developing agroecological classifications on the basis of climate and soil information, and in anticipating the effects of future pressures from growing populations on land and water resources.

3.2. Agroecological Characterization

Agroecological characterization puts agricultural and environmental concerns in perspective and is indispensable for better resource management and development of sustainable production systems that will meet future demands for food and feed. It allows also for comparison of production potentials between regions and assessment of research spillovers. At the highest level of aggregation of the agroecological classification by FAO (FAO, 1978-81) a distinction is made between tropical regions, subtropical regions with summer rainfall and with winter rainfall, and temperate regions. These major climatic areas are further subdivided into rainfed moisture zones, using a concept of reference length of the growing period and their associated thermal regimes.

The tropics are defined as those areas where the monthly mean temperature of every month in the year, corrected to sea level, is greater than 18°C. Subtropics are defined as those areas where the monthly mean temperature, corrected to sea level, is less than 18°C during at least one month in the year but with all months having monthly mean temperatures greater than 5°C. Temperate areas are those where the monthly mean temperature, corrected to sea level, is less than 5°C during at least one month in the year but the number of months with monthly mean temperatures below 5°C does not exceed nine.

The reference length of growing period (LGP) is defined as the period in days when soil moisture supply from rainfall and soil storage exceeds half potential evapotranspiration. Five moisture zones based on LGP classes are: dry, LGP = zero; arid, LGP = 1-75 days; semi-arid, LGP = 75-180 days; subhumid, LGP = 180-270 days; humid, LGP = 270-365 days.

The temperature conditions during the growing period are defined using three temperature classes and their combinations where temperature during the growing period has a marked seasonality (e.g. in the humid subtropics). The three temperature classes are: warm, mean daily temperature greater than 20°C; cool, mean daily temperature in the range 5-20°C; cold, mean daily temperature less than 5°C.

The distribution and extents of the most relevant zones within each region are described in the individual regional essays which follow.

3.3. Regional Importance of Commodities

In order to allow for an initial assessment in the importance of each of the broad commodity groups under consideration in this report - crops, forestry, livestock and fisheries - an estimate was made of the values of production of each of these groups in each of the major regions (Table 3.1.). The table captures some interesting differences in the relative values of production among commodities and regions. It also clearly shows, for example, the importance of crop production, which accounts for more than half the total value of production on a global basis. The table also illustrates the predominance of the Asia and Pacific region.

Table 3.1. Annual Gross Values of Production of Major Commodity Groups by Region in Developing Countries, 1983/85
(US$ Billion)

Commodity Groups	Region				
	Asia/ Pacific	sub-Saharan Africa	Latin America/ Caribbean	West Asia/ North Africa	TOTAL
Crops	200	42	73	26	341
Forestry	69	22	24	3	118
Livestock	51	8	32	11	102
Fisheries	14	2	8	1	25
TOTAL	334	74	137	41	586

Source: Using 1983-85 Production and Price Data from FAO or World Bank producer prices when FAO data were not available. The data and regional groupings refer to developing countries only.

In general, with research targeted to commodities, the more economically significant the commodity, the greater the expected economic return from research, resulting from a given productivity gain or cost reduction. This relationship provides a rationale for using the gross value of production of commodities as one of the determinants of priorities when the potential contributions of research to economic growth are primary considerations.

It should be recognized, however, that it is only one ingredient in the process of priority assessment for the CGIAR. Others are, for instance, the scientific assessment of research opportunities and their potential effects, the comparative advantage of alternative institutions for conducting the research, and considerations of equity in the distribution of the benefits.

As for the latter, it might very well be that research on commodities that are economically of relatively small global importance would benefit the poor or the development of less endowed regions. This might hold especially for research on crops such as sorghum and millet and intermediate products, such as fodder crops, pastures, draught power, manure and certain forest products that are hardly traded and have therefore no international price, but are indispensable inputs for production of priced commodities.

Another caveat is that prices may vary considerably by region and during the course of time, with consequent variation in the relative importance of the commodity concerned. This relative importance also depends on how commodities are aggregated. If, for instance, a distinction is made among various vegetables, they may each be of relatively small importance, but when lumped together as vegetables they can be regarded as important. A similar argument could be made for fisheries and fruits.

In spite of several problems, the gross value of the production of commodities is a useful indicator for the importance of commodity-orientated agricultural research. The gross values for major commodities are given in Table 3.2. for the developing world as a whole. Table 3.3. gives this information for the 25 most important commodities in the four regions that are distinguished in the sections which follow next. These gross values are the product of production and price data from FAO and generally for the period 1983-85. When FAO price data were not available, World Bank data were used. For non-tradable commodities, the latest domestic prices were used.

The economic importance of forestry should be highlighted. This is mainly due to the production of fuelwood and sawlogs. For the developing world as a whole as well as for Asia they are the second and third most important commodity, and in sub-Saharan Africa fuelwood is the first on the list. As for other non-traded commodities these data for fuelwood were derived from typical household consumption figures, local prices and population data and should be considered with considerable reserve. However, the relative position of fuelwood near the top of the list, is well established.

Of the non-food crops cotton and coffee are relatively high on the world list. Livestock production is important in Latin America/Caribbean and in West Africa/North Africa. In sub-Saharan Africa, the starchy foods are high on the list, with banana/plantain, cassava and sweet potato being the three most important.

Table 3.2. Gross Value of Production of Major Agricultural Commodities in Developing Countries (in US$ million)

Commodity	Gross Value	Commodity	Gross Value
Rice	70465	Charcoal	4831
Fuelwood (Non-Conif)	45769	Tomato	4530
Sawlogs (Non-Conif)	44430	Inland Capture Fish	4444
Milk	38970	Apple	4242
Wheat	27542	Cocoa	4113
Banana/Plantain	24107	Inland Culture Fish	3841
Maize	21664	Millet	3619
Pigs	26045	Marine Culture Fish	3512
Cotton	20741	Grape	3468
Coffee	18127	Coconut	3041
Beef/Buffalo	15398	Onion	2701
Sweet Potato	14846	Yam	2695
Marine Capture Fish	12818	Palm Oil	3343
Other Ind. R'wood	11072	Rapeseed	2447
Cassava	10586	Barley	2065
Orange	10068	Pitprops	2025
Eggs	10003	Wool	1872
Soybean	9658	Sunflower	1753
Pulses	9533	Cabbage	1742
Potato	9344	Pineapple	1727
Tobacco	8722	Lemon	1719
Sheep/Goat	4116	Pulpwood	1259
Sugar	7334	Rye	110
Groundnut	5385	Grapefruit	655
Sawlogs (Conif)	7015	Taro	495
Poultry	6748	Pepper	398
Tea	5586	Linseed	339
Sorghum	5167	Oat	198
Fuelwood (Conif)	4942	Vanilla	180
Rubber	3861	Duckmeat	158

Source: FAO Production and Price Data 1983-85.
When FAO price data were not available, World Bank data were used.

Table 3.3. Gross Value of Annual Production of the Twenty-Five Most Important Agricultural Commodities, 1983-85
(in US$ million per Region)

Commodity	Gross Value	Commodity	Gross Value
Asia		**Sub-Saharan Africa**	
Rice	65954	Fuelwood (Non-Conif)	12489
Sawlogs (Non-Conif)	30202	Banana/Plantain	8518
Fuelwood (Non-Conif)	24685	Sawlogs (Non-Conif)	4844
Wheat	19431	Sweet Potato	4406
Milk	18874	Cassava	4377
Pigs	21595	Coffee	4008
Cotton	13821	Milk	2894
Maize	12095	Yam	2624
Sweet Potato	9973	Other Ind. R'wood	2593
Potato	6905	Beef/Buffalo	2425
Other Ind. R'wood	6448	Cocoa	2361
Tobacco	6098	Maize	2064
Banana/Plantain	5968	Charcoal	1721
Pulses	5878	Sheep/Goat	801
Eggs	5822	Groundnut	1069
Groundnut	4018	Cotton	1518
Rubber	3606	Sorghum	1162
Cassava	3906	Millet	1147
Marine Capture Fish	3799	Rice	1092
Tea	3721	Inland Capture Fish	1044
Inland Culture Fish	3720	Pulses	921
Sawlogs (Conif)	3393	Marine Capture Fish	919
Marine Culture Fish	3362	Tea	633
Fuelwood (Conif)	3311	Eggs	608
Soybean	3303		
Latin America/Caribbean		**West Asia/North Africa**	
Coffee	11930	Milk	5357
Milk	11845	Wheat	5153
Beef/Buffalo	9538	Sheep/Goat	1496
Banana/Plantain	9530	Pulses	2385
Sawlogs (Non-Conif)	8981	Cotton	2353
Fuelwood (Non-Conif)	7755	Tomato	2056
Marine Capture Fish	7161	Grape	1938
Maize	6576	Orange	1689
Orange	6409	Beef/Buffalo	1343
Soybean	6214	Apple	1330
Sugar	3701	Barley	1271
Pigs	4063	Poultry	1082
Sawlogs (Conif)	3025	Eggs	990
Wheat	2772	Other Ind. R'wood	980
Poultry	2769	Potato	968
Cotton	3048	Marine Capture Fish	939
Rice	2614	Maize	930
Eggs	2582	Fuelwood (Non-Conif)	839
Cassava	2303	Rice	805
Charcoal	2027	Onion	698
Sorghum	1716	Tobacco	579
Tobacco	1502	Sugar	490
Cocoa	1443	Sawlogs (Conif)	485
Grape	1336	Wool	476
		Fuelwood (Conif)	450

The information on value of production provided in the tables illustrates, among other things, the importance of certain non-food commodities in the agricultural sector, and provides an indication of their contributions to the generation of income and employment.

3.4. Asia and the Pacific

3.4.1. Population and Land Use

More than two thirds of the population of developing countries lives in Asia and the Pacific region, i.e. 2.6 billion people. Between now and the year 2025, the population of this region is expected to increase by a further 500 million people every decade. The area's average GDP amounts to US$ 466 per caput, which is about equal to that of sub-Saharan Africa but well below that of the Latin America and WANA regions. Despite substantial improvements in food production during the last 25 years, Asia continues to have the largest incidence of poverty and malnutrition. Approximately 50% of the region's population lives below the poverty line, and more than 300 million people are chronically malnourished. The region is having a major struggle in maintaining food supplies per caput and the outlook for a dramatic improvement in the nutrition and income of the poor is not optimistic. Food production has to increase by 100 million tonnes every decade to keep average consumption per caput at current levels. The amount of available arable land in Asia and the Pacific is only 0.2 ha per caput, or approximately half the average of developing countries as a group. The need to improve agricultural productivity, income and nutrition will put increasing pressure on the natural resources of the region and the sustainability of cropping systems at risk. In addition to the high density of the rural population, the main features of agriculture in Asia are the prevalence of small-scale farms, the scarcity of additional arable land, and the monsoon rainfall patterns (Vyas and James, 1988). For the purposes of this report, Asia and the Pacific have been considered as one region, but it is acknowledged that there are important intraregional differences in terms of resource endowment, political systems, poverty, human nutrition and food security.

3.4.2. Land Resources and Environmental Concerns

Of the total area of 896 million ha (excluding China, Korea, Mongolia, Papua New Guinea), 84% of the Asia and Pacific region has a climate suited to the rainfed production of crops. Of the total climatically suitable area (755 million ha), 85.5% is in the warm tropics, 11% in the warm subtropics (summer rainfall), 1.8% in the cool tropics, 1.6% in the cool subtropics (summer rainfall) and 0.1% in the cool subtropics (winter rainfall). Of the total climatically suitable area in the warm tropics and warm subtropics (summer rainfall) (728 million ha), 27% is semi-arid, 33% is subhumid and 40% is humid. Of the total climatically suitable area in the cool tropics, cool subtropics (summer rainfall) and cool subtropics (winter rainfall) (26 million ha), 13% is semi-arid, 28% is subhumid and 59% is humid.

Due to soil and landform constraints, the total area of arable land in the Asia and Pacific region amounts to 448 million ha, or around 18% of the global land area. Yet there is little room for an expansion of rainfed cultivated land and urban development is reducing the area of

good agricultural land near cities. The cropping intensity for Asia (harvested land/arable land), excluding China, amounts to 108%, some of the excess being due to double cropping (FAO, 1987). Most of the land reserves that exist are located in Indonesia, Kampuchea, Ma[illegible] The Union of Myanmar (Burma) and Laos. (FAO, 1984). Although t[illegible] region is endowed with large alluvial plains and deltas which are fertile and offer generally high population supporting capacities, major efforts are needed to prevent soil degradation and ensure appropriate soil management, especially in marginal upland areas.

In South and Southeast Asia nearly 85% of soils are constrained by mineral deficiency, drought, shallow depth, or excess water. Deficiencies of nitrogen, phosphorus and micronutrients are widespread in the region. In high-rainfall areas, heavily leached acid soils constitute 70-90% of the total land area, and are often poor in plant nutrients and low in organic matter (FAO, 1984). Soils in some areas of the region are low in trace minerals essential to humans and livestock, notably iodine and selenium, leading to nutritional deficiency diseases. Throughout the Asia and Pacific region, steep slopes pose serious limitations to cultivation. In Central Asia, 55% of land is on slopes of above 30%. In Oceanic Asia, 69% of land falls under this category. In South and Southeast Asia, 60% of the land has slopes greater than 8%. Many soils on these steep slopes are stony, shallow and subject to erosion. Throughout the region, poorly drained soils are found. Vertisols (heavy cracking clay soils) occur extensively in India where they are mostly cultivated during the post-monsoon period on stored moisture.

Land degradation is a major problem in many parts of the region. In India more than half of the total area is affected either by water or wind erosion, salinity or flooding. Soil erosion needs to be controlled urgently, otherwise rainfed arable land area and its productivity for crop production could be reduced substantially. In arid areas, irrigated lands face the threat of salinization and waterlogging.

Land degradation is a man-made phenomenon, particularly that following deforestation, which is progressing rapidly in the area, and has been estimated to amount to 1.5 million ha a year in India alone. During the last 25 years, 40 million ha were deforested in tropical Asia and if present trends continue, by the year 2000 a further 36 million ha of forests will have been converted to new uses. Fuelwood and minor forest products (fibre, fruit, medical products) account for a high proportion of all wood and forest products consumption, pointing out the need for research emphasis to focus more on these products than on industrial wood which historically has commanded most of the attention. Although in the past, deforestation partly constituted a logical shift to more productive agriculture, in recent years it has occurred mainly on steep upland slopes or on acid soils in lowland humid tropics where it has negative ecological consequences. These problems are becoming increasingly serious in the small island countries of the Pacific where steepland agriculture is of major importance.

Given the scarcity of new land for cultivation, agricultural productivity per unit of land will have to be increased to respond to the changing demands of a rapidly growing population. Development and dissemination of productive technologies are essential preconditions for an adequate and sustainable response to this challenge. Technologies for rehabilitation of degraded lands, e.g. saline or acid soil areas, are needed to expand the area of land under cultivation.

3.4.3. Challenges to Research

3.4.3.1. Crop Productivity

Production of cereals, pulses, and roots and tubers is the main agricultural activity throughout Asia. Rice and wheat are the dominant crops, and maize is also widely grown. During the last 25 years, substantial increases in cereal production have been achieved, through improvements in yields and through initiation of multiple cropping in irrigated areas. In particular, spectacular gains were made in the productivity of wheat and rice in favourable environments. Three important changes accounted for three quarters of the increased production: modern varieties, irrigation, and fertilizers. Recent indications (Byerlee, 1988; Pingali and Moya, 1989) suggest that farmers that operate under good economic conditions and in favourable environments may be reaching the same yield levels as are achieved on experimental stations. Under these conditions, there appear to be less opportunities for expansion of fertilizer use although there are still considerable imbalances between countries. However, there is considerable scope for improving fertilizer use efficiency and crop husbandry. Modern varieties will provide less opportunities as a source of growth. No major breakthroughs in yield potential are being made at present and recent CGIAR efforts in breeding have given greater attention to enhancing yield stability.

Under favourable conditions, the so-called "yield gaps" have been diminishing for cereal crops, but the rapid increases in productivity have not been matched in the less favourable rainfed environments. Significant productivity gains have been made in food legumes, particularly pigeonpea and soyabean. In many other situations, progress has been sluggish because of unfavourable development policies and economic conditions. These make investments in the improvement of irrigation systems and favourable rainfed environments unattractive and constrain the development of appropriate crop husbandry systems. In addition, in many Asian countries, seasonal labour bottlenecks and the cost of this labour have become a major constraint to agricultural productivity, particularly for planting, weed control and harvesting. These observations point to the need for research to improve the structure and management of irrigation systems. Such improvements are also needed in favourable rainfed environments with suitable soils (e.g. bunded rice).

Another important way to improve input efficiency, sustainability and yield stability is through the integrated management of water, fertilizer, diseases, insect pests and weeds. Productivity would also be increased by improving agricultural policies and timely supply of inputs. Parallel to this, a major research effort to raise the yield potential of rice and wheat is also needed, as the potential payoff is likely to be substantial. In the long run, such increases will be essential to enable food production to keep pace with population increases.

In the more marginal upland areas, there is scope for increasing crop productivity through improved soil management and the use of agroforestry. Research for these areas has been relatively neglected in the past as most of the research investment has been directed at irrigated areas. It is noteworthy that the stabilization of steeplands in Asia and the Pacific is important not only to increase crop

production in situ but also to reduce offsite impacts of silt on water reservoirs used for crop irrigation of lowland favourable environments.

Throughout the Asia and Pacific region, it appears that during the next two or three decades high priority should be given to research on the sustainable improvement of irrigation and its management, and on crop and resource management. At the same time, major efforts to increase the yield potential of rice and wheat should continue; in these efforts new approaches, including the application of modern biotechnology, will be needed. Greater attention should be given to the research needs of upland areas, particularly with respect to food legumes, roots and tubers, and coarse grains, for which the demand is increasing rapidly, both for food and animal feed.

3.4.3.2. Livestock Productivity

A major part of the world's livestock population exists in the developing countries of the Asia and Pacific region, i.e. 97% of buffaloes, 30% of cattle, 56% of goats, 48% of pigs, 28% of sheep, 36% of chickens and 87% of ducks. Livestock constitute an integral part of the farming systems of the region, and the primary role of cattle and buffaloes is to provide milk, meat and draught power. Livestock manure is of substantial importance as a source of crop nutrients and household fuel. Offtake rates for cattle and buffaloes are low because of their use for draught power which is a key factor in farm productivity. Although Asia has a large share of the world's population of cattle and water buffalo, it produces only 10% of the world's cattle and buffalo meat. Offtake rates for sheep and goats are also low, because of their importance as a source of security and investment.

Demand for livestock products, particularly for poultry products, has been rising faster than supply, particularly in those Asian countries with high economic growth rates. There has been little improvement in livestock productivity, other than in pigs and poultry. One of the primary constraints to improving livestock productivity in the region is poor nutrition and management. To date, the expectation that the green revolution would lead to increased supplies of crop by-products and diversification of production on marginal lands into fodder and oilseed crops, has not been realized (De Boer, 1982). Imports of coarse grains and oilseed products have risen sharply in middle-income countries. The impact of research has been small because, in the past, research has given inadequate attention to farmer resources and objectives in smallholder production systems. Future research will have to give greater attention to the role of animals in farming systems. There is also scope for a major expansion of smallholder dairy production throughout Asia. At the farm level, the intermediate functions of livestock (draught power, manure, security) are often of substantial importance and this aspect should be reflected in the research approach. A livestock research strategy for Asia should give particular attention to improving the quality and quantity of crop by-products, feed resource base and methods of strategic seasonal feed supplementation, breed improvement, disease control, and improved marketing.

3.4.3.3. Forest Productivity

The contribution of forests to economic growth has been declining sharply in Asian developing countries during the last decade because of the depletion of forest resources. This is despite the fact that the region's rainforests are among the richest ecosystems on earth and contain about half of the world animal and plant species, many of which have not yet been described. Little research has been carried out to improve the understanding of tropical forest ecosystems and their environmental and biological roles.

Most of the past work on germplasm conservation has focused on food crops. Despite the fact that tropical forest ecosystems supply many staple foods and contain wild relatives of modern food crops important for future breeding programmes, research programmes for collecting forest-based germplasm are scattered and weak.

Given the need to maintain soil fertility and reduce soil erosion, the shortage of animal feed, and the pressures to increase the supplies of fuelwood rapidly, there appears to be a large potential for agroforestry in the region. While considerable work has been done in the last decade on developing a better understanding of farmer and community perceptions of the usefulness of agroforestry systems, major gaps in knowledge lie in quantification of these relationships and in developing a better understanding of the conditions that will induce accelerated reforestation. There is a need for research on selection and breeding of fast growing multipurpose species and on adoption of sustainable agroforestry systems for reclamation of saline wastelands and reforestation of upland areas.

With respect to fuelwood conservation and production, future research efforts will include price policy and market analysis to encourage use of substitute fuels (particularly in urban areas); policy environment to conserve fuelwood; and an increasing production of fast growing multipurpose trees. Key areas for fuelwood research will be the investigation of tradeoffs between close and wider espacement of biomass planting, the improved understanding of harvesting practices that will avoid nutrient drain, the potential for fertilizer application, and a better integration between fuelwood production with exploitation schemes for timber and other woody products.

As industrial and social forestry move towards increasing dependence on fast growing plantation species, there will be a need for expanded research in such areas as soil microbiology (particularly the potential of innoculation with mycorrhiza to improve seedling survival and to increase yields); tree selection, breeding and improvement; and on exploratory research on the potential of modern biotechnology to contribute to improved disease resistance and development of biological processes for making use of wood waste.

Policy research in forested (or deforested) upland watersheds is needed to develop better understanding of the complementarity of agricultural forestry and energy-related policies and to develop sustainable land use systems. There is also an urgent need to develop a data base on forest resources and their uses.

3.4.3.4. Fish Productivity

The Asia and Pacific region produces an annual fish catch of over 25 million tonnes. This represents nearly 40% of the world's total marine fish catch, and 80% of inland fish and aquaculture production. The gross value of production of fisheries in the Asia and Pacific region amounts to US$ 14 billion, of which 28% originate from marine capture, 25% from marine culture, 19% from inland capture, and 28% from inland culture fisheries. Fish provide a major source of animal protein in most countries of the region, contributing about 30% of its supply. In some countries fish also provide vital sources of foreign exchange, income and employment. The economy of most of the Pacific countries is largely dependent on the fishing sector, but capture fisheries may be reaching a production plateau. Coastal fisheries resources are often depleted due to open access policy and inadequate fisheries planning and management in many countries. Most of the potential for increased production lies in the expansion of aquaculture which currently represents 20% by volume of the total catch and close to 30% by value.

Although less than 10% of farmers and coastal dwellers are involved in aquaculture, it has a long history in the region and freshwater aquaculture in particular is expanding rapidly. Most of the output is finfish (4.4 million tonnes), molluscs (2.6 million tonnes), crustaceans (312,000 tonnes) and seaweeds (2.75 million tonnes) (FAO, 1989). The diversity of finfish species is the widest in the world. Crustacean culture is the most rapidly expanding sector of aquaculture production in Asia, due to high profits and the potential for foreign currency earnings. Asia now accounts for 75% of the world total of farmed crustaceans and for 99% of the production of seaweed (FAO, Ibid).

Many of the constraints to culture-based fisheries are location specific and involve management or socioeconomic problems. For aquaculture, and to some extent culture-based fisheries, there is a strong need for strategic research on nutrition and germplasm enhancement, and the development of culture systems. Some Asian countries also face major disease problems and have difficulty in producing seed, highlighting the need for research on integrated insect pest and disease management. Environmental pollution from industry and agriculture has also caused major production difficulties and there is a major need for research on the management of coastal areas.

3.4.4. Policy Environment

Agricultural development in the Asia and Pacific region since the early 1970s has been relatively successful, although there are intra-regional variations. In general, however, per caput food production has increased steadily and various countries have reached food self-sufficiency. A major reason for this improved performance has been the active role of governments in promoting agricultural development, providing production support, investing in infrastructure, promoting technology development, and in initiating institutional reforms in land tenure, credit and labour (Vyas and James, 1988). Yet, in almost all countries throughout the region, policy deficiencies remain, particularly with respect to price policies, input subsidies, the widening income gap, and operational and institutional arrangements for the equitable distribution and management of water. Poor policy and planning in the fisheries and aquaculture sector have also caused major environmental and production sustainability problems.

3.4.5. Strength of National Programmes

The success of agricultural development has also generated a rapid increase in agricultural research expenditures, which more than tripled in real terms during the last two decades (Pardey and Roseboom, 1988). Although the number of scientists has increased dramatically, funds available per scientist have reduced. Most large countries in Asia appear to have good research programmes for plant breeding in basic food crops. The capacity for crop and resource management research is generally weaker and often fragmented among disciplinary groups. Social science research capacity is also limited (Byerlee, 1988). The links between research and extension services need strengthening and operating funds receive an inadequate share of the research budgets. Finally, greater emphasis should also be given to agricultural education and its links with research.

3.4.6. Conclusions

Food production in Asia and the Pacific will have to continue to grow rapidly in order to keep pace with population increases and to improve nutrition. Agricultural development in the region also has to play a crucial role in income and employment generation and natural resource conservation. Research efforts will have to be carefully balanced between the needs of rainfed upland areas and those of irrigated areas.

In the near future, it is possible that for rice and wheat there will be slower growth from the main sources of increased productivity during the last two decades, i.e. modern varieties, irrigation and fertilizers. Research should therefore emphasize the development of cost reducing technologies to improve crop and resource management and promote nutrient use efficiency. Efficient use of inputs is also essential if environmental problems such as pollution of ground and surface waters by agricultural chemicals is to be avoided. Efforts are needed to strengthen the capacity of national programmes to undertake research, especially in neglected fields such as resource management. For the longer-term future, it will be essential to increase the yield potential of the principal cereal crops. With respect to upland areas, greater attention should be given to research on food legumes, coarse grains and roots and tubers. Attention should also be given to increasing the productivity of income-elastic foods, such as vegetables and livestock products, which have the additional advantages of supplying vitamin A, B-complex vitamins, iron and other minerals that are deficient in regional diets; and of being labour intensive and income generating. Aquaculture and improved management of capture and culture based fisheries could also play a major role. Policy research, integrated pest management, forest research and the development of agroforestry should become essential components of any research strategy for the region.

3.5. Sub-Saharan Africa

3.5.1. Population Growth and Land Potential

The population of Africa south of the Sahara is projected to reach 910 million by 2010 and 1.3 billion by 2025. Across sub-Saharan

Africa GDP has grown at a rate of 2.3% per annum over the period 1985-87. This reverses the 1.1% per annum decline in GDP over the previous four years but remains lower than the 3% rate of increase in population. Per caput GDP was about 15% lower than a decade earlier. Though the rate of increase in population will begin to fall by 2000, the net reproduction rate will reach unity (NRR=1) only by 2045. Current forecasts put the eventual stationary population at 2,072 million people.

Africa south of the Sahara has a total land area of 2,364 million ha. Estimates by FAO (FAO, 1986a) show that the requirements of the 2010 population for crops, livestock products and fuelwood cannot be met at existing yield levels in three sub-regions; Sudano-Sahelian, sub-humid and mountainous East Africa and sub-humid and semi-arid Southern Africa. These three sub-regions will contain 55% of the expected 2010 population.

These estimates of sub-regional land requirements assume an even geographical spread of population and mobility across national boundaries. Neither assumption is realistic. Many areas are more heavily settled. Current densities rise to more than 500 people per km^2 in parts of Western Kenya, Rwanda, Burundi and Eastern Nigeria. At the same time, large areas of Central Africa with a humid tropical climate carry under 10 people per km^2. These radical differences in density at the national and sub-national levels highlight the need for analysis at and below the country level.

FAO showed that 29 countries with populations totalling 466 million people will reach a critical state by the year 2000 when food and fuel needs will have exceeded the production capacity of the available land at current yield levels. With productivity static over recent years, these pressures are already reflected in forest depletion and land degradation, in the build-up of food imports, particularly wheat and rice for the growing urban populations, and in the increased dependence of the continent on food aid. Malnutrition is likely to continue to be severe, and FAO expects the share of the population below the 1.4 Basic Metabolic Rate (BMR) threshold in the year 2000 to be only a little below that of the 1979/81 pre-drought period. Absolute numbers would increase, however, by more than 75% during the period 1971/81-2000.

3.5.2. Africa's Resources

3.5.2.1. Land Resources and Environmental Concerns

Of the total area (2,364 million ha), 63% of the sub-Saharan Africa region has a climate suited to rainfed crop production. Of the total climatically suitable area (1,493 million ha), 94% is in the warm tropics, 5.6% is in the cool tropics (highlands), 0.3% is in the warm subtropics (summer rainfall), and 0.1% is in the cool subtropics (summer rainfall) (highlands). Of the total climatically suitable area in the warm tropics and warm subtropics (summer rainfall) (1,406 million ha), 35% is semi-arid, 35% is subhumid and 30% is humid. Of the climatically suitable area in the cool tropics and cool subtropics (summer rainfall) (86 million ha), 29% is semi-arid, 50% is subhumid and 21% is humid.

Currently 11% of sub-Saharan Africa's food needs are met from 5 million ha of irrigated lands. Prevailing high capital and management

costs for large scale schemes together with high unit costs for small-scale schemes, underlie FAO's assumption of only 1% increase in area per year. Wider possibilities are seen for small scale supplementary irrigation and an increase of 3% per year could be anticipated, if the necessary policies, investment, and incentives were introduced.

FAO identifies 10 major soil associations in Africa. Two associations; desert soils (620 million ha) and shallow soils (376 million ha) have low agricultural potential. Sandy soils cover 577 million ha. With low - medium potential these are subject to moisture deficit, compaction, crusting, poor water retention and low nutrient content. Acid soils cover 509 million ha of the tropical lowlands and are of medium to high potential under good management. These tend to suffer from aluminium toxicity and phosphorus fixation. Poorly drained soils cover 276 million ha. Subject to waterlogging and some acidity, they are of medium to high potential where water control is possible and there is no acidity. Other soil associations important south of the Sahara are ferruginous tropical soils (194 million ha), dark clay vertisols (99 million ha) and the highland soils (39 million ha) all with medium to high potential when well managed. Increasing population pressure is overwhelming the traditional systems of fertility maintenance and forcing farmers on to increasingly marginal lands which cannot be managed in a sustainable way by traditional methods. In most parts of Africa it is estimated that nutrients are being removed in crops at ten times the rate they are being applied as fertilizers. Under such management, soils inevitably lose productivity and are degraded. The need for increased nutrient inputs and better soil management is obvious in this region.

3.5.2.2. Forest Resources

About one quarter of the total land area is wooded or forested, nearly half supports grass with or without shrubs and trees and much of this is suitable for grazing. Some 135 million ha have been set aside either as nature reserves or national parks and provide a habitat for wildlife. These areas play a key role in conserving germplasm and in contributing to Africa's significant revenues from tourism.

The increasing pressures from population and livestock have caused the over-cutting and over-grazing of woodlands. This has caused an excessive drain of nutrients from forest soils, exacerbated soil erosion, accelerated water runoff and created serious localized shortages of fuelwood and fodder. Over-cutting of trees and shrubs at the farm level exposes soil and crops to dry winds and has a significant effect on yields.

Although the continent currently has 700 million ha of tree cover only 210 million ha are enclosed forests. About 490 million ha are open savannah woodlands. Deforestation is proceeding at a rate of about 3.7 million ha a year.

3.5.2.3. Fishery Resources

African inland fishing waters total more than 450,000 km^2, or about 2% of the total continental area, and are dominated by large lakes

and reservoirs. Fish and fisheries are important as sources of employment and income. Where fish play a prominent part in national dietary patterns, inland fisheries provide a significant proportion of total supplies. There are some 700,000 inland fishermen on Africa's inland waters and each generates employment for perhaps as many as 5 additional people who process, transport and market the catch. Coastal fisheries are also important and account for 50% of total fish catch. The value of fisheries production in sub-Saharan Africa can be estimated at about US$ 2 billion per annum.

3.5.3. Land and Labour Productivity and Research Needs

Many factors common to African countries have inhibited the intensification of production and have helped to make the extension of the cultivated area attractive, such as the availability of unused land; underdevelopment of markets; poor infrastructure; policy distortion; communal land tenure, inhibiting individual responsibilities for resource maintenance; and a lack of technological innovations for production, especially those appropriate for the small farmer. In any local farming situation, any one of these factors may inhibit intensification.

While area extension has historically been the main avenue for absorbing the increasing African population, FAO shows that the rate of opening new land reduced by 30% in Africa between 1961 and 1980 as reserves in some countries were exhausted. New land is less and less an option and where it is, it merely offers a breathing space to focus on the only long-term viable option of improving productivity on existing cultivated lands. With rural populations expanding over the next 30-40 years, the increased demand for food and income will exacerbate pressures on soils, grazing and forests, mainly for the following reasons:

- settlement is pushed into increasingly marginal areas, with relatively poor rainfall and fragile soils
- existing technology is rarely appropriate for the more marginal areas where people tend to be poorer and cannot afford the inputs needed to sustain production
- encroachment on pastoral and forest lands raises the costs of grazing and fuelwood from the reduced area
- intensification of shifting cultivation reduces fallow periods and crop yields and can lead to rapid soil degradation.

As the costs of expanding into new areas increase, a point is eventually reached at which the only economic option for farmers is to intensify their production. When this happens, it creates a more favourable environment for technological innovation and greater demand for the results of research.

3.5.3.1. Crop Productivity

The current productivity of cropland is low. For the more suitable growing areas, known potentials of the main staples are greatly

in excess of present yield levels. Research should therefore emphasize exploiting as well as increasing known potentials. Breeding for resistance to, or tolerance of, the major insect pests and diseases is particularly important because of the low cost approach to control offered to resource-poor farmers. In the more suitable growing areas the adaptation of known production principles to small farmers circumstances will help to contain population spread to increasingly marginal areas and encroachment on grazing and forest lands. In terms of value of production, the most important crops are banana and plantain, sweet potato, cassava and coffee.

Commercial farmers have consistently achieved high crop yield levels through fallow rotation and the use of fertilizers. With pressure on the land, however, small farmers no longer have opportunities for fallow rotation. Consequently, fertility maintenance and soil conservation will be achieved only through the use of manure and fertilizers, and additional applied research will be needed, particularly on the efficient use of purchased inputs and on the long run effects of increased cropping intensity, even on the better land areas. Agroforestry, with nitrogen-fixing trees, and managed fallows are alternative approaches to improving soil fertility and should therefore receive more attention from researchers. The interaction of the limited power resources at the disposal of small farmers and their crop management practices is strong enough to highlight tillage and weed control as further key research needs, especially given the importance of mixed crop-livestock systems in the region.

There is much less commercial experience with cropping in the semi-arid areas and a far weaker foundation of management principles from which to adapt small farmer practices. In these more risky areas, research strategy to ensure economic returns will be a prerequisite to attracting farmers to purchase inputs for intensification. Two key areas are identified. First, improving the efficiency of use of the limited rainfall available. Second, widening farmers' options to give them greater flexiblity to manage the uncertain timing of the rainfall through better crop management. The use of small scale irrigation devices to increase reliability by supplementing rainfall will be one important direction for these areas, in particular. Development of irrigation and particularly of indigenous expertise in irrigation management would help reduce pressures on rainfed marginal land.

Success in stabilizing returns will still leave significant uncertainties, and low cost options for fertility maintenance are a further important target for research. This should include the use of organic materials to complement the use of fertilizers. A knowledge of local farmers' circumstances will be important for the design of appropriate innovations. Fertilizer availability and affordability to farmers is a key issue which must also be addressed.

3.5.3.2. Livestock Productivity

The livestock populations of Africa represent a massive resource in their own right. The continent has some 163 million cattle and 300 million sheep and goats. In addition to milk and meat, the intermediate products from cattle in the form of draught power and manure are also important. The annual gross value of production, not including intermediate products, is estimated at US$ 8 billion a year. Livestock

productivity is low and the improvement of animal nutrition and management is a high priority. Reproductive efficacy can also be improved through better nutrition, management and health care. The management and availability of fodder resources, including the use of trees and shrubs, and also range and grazing management are key determinants of production. Two interacting social issues deter technical improvement: the communal tenure of pastoral lands and the use of livestock as a hedge against climatic and economic uncertainty. Both usually motivate owners towards quantity rather than quality and inhibit offtake for the market. As with crops, experience with beef and milk production on commercial farms has demonstrated potentials several times current productivity levels even in the semi-arid areas. For many countries, the development of a positive policy framework, creating the incentives for intensification of milk and meat production, will be a prerequisite for farmer acceptance of improved animal husbandry. Beyond this, breeding and feeding strategies for the herds of small farmers, with emphasis on both intermediate and final products, will be important directions for research. Animal health continues to be a dominant concern in most of Africa. In addition to trypanosomiasis and tick-borne diseases, endoparasites in small ruminants constrain production in major sub-regions.

3.5.3.3. Forest Productivity

In addition to the more obvious forest products, such as fuelwood, building poles, timber, furniture, pulpwood and paper, the productivity of Africa's forests, woodlands and perennial tree crops can be measured by their direct contribution to cash income as well as their indirect contribution to agriculture through the maintenance of soil nutrients and the protection of soil and water resources. The productivity of forest and farm trees is running well below their potential.

Future research strategies have two main directions. First, towards improved understanding of the underlying causes of deforestation and the potential for policy reforms and the conservation of remaining and restored forest resources. Second, towards cost-effective incentive policies and technological improvements for encouraging farmer and community involvement in reforestation, including mixed crop-livestock-tree systems, and sustainable natural forest management.

Three areas of work will be of particular relevance: the development of silvicultural systems for upgrading the productivity of natural woodlands; the improved quantification of the potential contribution of trees and shrubs to crop and livestock production systems; and the improvement of multipurpose trees for farm and industrial uses.

3.5.3.4. Fish Productivity

The catch of inland water fish has remained relatively constant at about 1.4 to 1.5 million tonnes per year since the mid 1970s. This stagnation results in large part from overfishing in all but the largest lakes and reservoirs, and the great practical as well as policy difficulties in enforcing more judicious use. In general, the larger bodies of water are underutilized. Output from coastal waters is low

because of the artisanal nature of the production systems. The data base on fish resources and their uses is very weak, however, and major improvements are needed to allow for the formulation of more effective policies.

Modern aquaculture has been slow to develop in Africa, owing to lack of experience, a lack of local supplies of fish seed, and poor infrastructure. Intensive culture is also constrained by the relative lack of market potential for the more expensive types of fish. Virtually all countries of the region lack appropriate legislative support for an orderly development of aquaculture, or have only recently organized action to provide such support. There is little determined support for programmes of aquaculture development at the level of planning and policy formulation, except in countries such as Rwanda and Malawi with population densities already close to their carrying capacities.

3.5.4. Conclusions

Known production principles for crops, livestock and trees have been successfully applied in both the commercial farming and the forestry sectors, and particularly, at least for crops, in the better growing areas. This experience has demonstrated that the potential for significant yield increases exists in all sectors. There is a clear priority for research to exploit existing potentials by a strong emphasis on resource management for improved crop, animal and forestry productivity. Such research must be complemented by continued efforts to increase genetic adaptation to specific needs, especially by breeding for resistance to major stresses.

As well as having implications for international research, all these approaches place heavy emphasis on building the capacity of the national agricultural research services to develop farmer-orientated technological innovations. Finally, policies are needed to create a production environment which offers incentives for farmers to intensify the sustainable use of their land and provide infrastructure for the distribution of inputs and the marketing of products.

3.6. Latin America and the Caribbean

3.6.1. Population, Poverty and Land Use

One of the most important challenges faced by countries in the region during the next 3-4 decades is that of making the agricultural sector a major source of economic growth so as to provide employment and help to alleviate the high incidence of poverty and malnutrition that prevails in most countries. The challenge is further complicated by the need to avoid further deterioration of the resource base. It is in this context that the role of international agricultural research is analyzed. Latin America is composed of Central and South America, two distinct regions, but for the purposes of this analysis their needs have been discussed in a common framework.

Some 137 million people were estimated to be in absolute poverty in 1980, representing close to 37% of the region's population (FAO,

1988 a and b). Poverty affected nearly two-thirds of the rural population, half of which had insufficient income to afford a minimum food diet. About a quarter of the total urban population was also in absolute poverty. Levels of unemployment and underemployment were already high in 1980 and have increased considerably since then as a result of the debt crisis, which has resulted in a considerable fall in real wages. These circumstances have, no doubt, contributed to the aggravation of the poverty problem and of the risk of malnutrition among the poor during the 1980s.

During the next 35 years, the region's population will nearly double, reaching a total of 761 million by 2025. Urban population will increase by 135%, while the total number of people in the rural sector will remain essentially constant. This means that the agricultural sector, with about the same labour force, would need to produce surplus food, fiber and forest products for more than twice the population of today. This, plus the need to increase per caput food availability, implies that average labour productivity in agriculture needs to increase at least two and a half fold by 2025. In addition, because of foreign exchange constraints and the debt crisis, the agricultural sector will have to contribute to import substitution and expansion of exports.

In the past, increases in production and average labour productivity have been achieved largely through area expansion and mechanization. The region is still well endowed with land per caput, particularly when compared to other developing regions. The proportion of land reserves (78%) is similar to that in sub-Saharan Africa (75%). However, even in countries with low average population densities, several areas, such as the Andean highlands and the north-east of Brazil will experience excessive pressure with detrimental consequences for the environment. The root of the rural poverty problem is the dichotomy which characterizes the region's agrarian structure, with the commercial farm sector controlling most of the land resources and the large peasant sector often occupying marginal lands which are gradually becoming worse (FAO, 1988 a and b). Land is abundant at the regional level in physical terms with respect to population, but socially scarce because small farmers have limited access to non-fragile land resources. In most Caribbean islands, however, and in some Central American countries, land is already physically scarce and it will become increasingly scarce in Mexico and Peru over the next 40 years.

3.6.2. Land Resources and Environmental Concerns

Of the total area (2,028 million ha), 83% of the Latin America and the Caribbean region has a climate suited to the rainfed production of crops. Of the climatically suitable area (1,680 million ha), 72% is in the warm tropics, 11% in the warm subtropics (summer rainfall), 7% in the cool tropics, 6% in the cool subtropics (summer rainfall), 1.2% in the cool subtropics (winter rainfall) and 0.6% in the cool temperate (winter rainfall) zone. Of the total climatically suitable area in the warm tropics and warm subtropics (summer rainfall) zone (1,419 million ha), 13% is semi-arid, 21% is subhumid and 66% is humid. Of the total climatically suitable area in the cool tropics and cool subtropics (summer rainfall) (230 million ha), 37% is semi-arid, 25% is subhumid and 38% is humid. Of the total climatically suitable area in the cool subtropics (winter rainfall) and cool temperate (winter rainfall) zone (31 million ha) 66% is semi-arid, 13% is subhumid and 21% is humid.

Environmental concerns are of increasing importance throughout the region. The most important ones in terms of sustainability of production are in priority order: soil degradation (particularly erosion and loss of fertility); indiscriminate deforestation, followed by non-sustainable annual food cropping and cattle ranching on infertile forest soils; desertification in semi-arid regions; low genetic diversity of commercial cultivars and increased risk of pests; and salinization of some irrigated areas.

Often, soil degradation, deforestation and desertification originate from prevailing socioeconomic circumstances associated with limited access to land by small farmers, from inappropriate policies (e.g. tax shelters for developing new areas where production is not sustainable), or from both. Undoubtedly, research has a critical role to play in providing viable alternatives for alleviating these problems and in the development of policies for sustainable land use of watersheds and forests. In the particular case of the increased risk of genetic vulnerability, agricultural research has a leading role to play.

The solution of most of the environmental problems, however, will ultimately depend on the adoption of policies for land use and development that are appropriate for the socioeconomic circumstances and resource endowments of each country. The needs are for technologies and policies that aim at reducing the pressure on supplies of timber and on agricultural expansion into the fragile areas, i.e. technologies and policies that aim at fostering increases in cropping intensity and yield in the less fragile environments.

3.6.3. Development Paths and Technology Needs

Any development strategy in Latin America and the Caribbean cannot ignore the small farm sector that represents around 80% of the production units and provides the bulk of the rural employment. Close to 40% of the production for the domestic markets originates in the small farm sector (Lopez Cordovez, 1982). The sector utilizes less capital and imported inputs, and more labour-intensive methods, thus making more efficient use of the socially available resources than the large farm sector. The development of the technological and policy environment conducive to active participation by small farmers in the development process represents one of the major challenges faced by policy makers throughout the region. To the extent that this is achieved, the demand and supply of food, fibre and forest products will increase simultaneously, and provide growth for the rest of the economy through the various backward and forward linkages. In order to increase forest productivity, there is a need for the introduction of effective forest management principles.

The results of a simulation exercise undertaken by FAO (1988 b) indicate that intensification (increase in cropping intensity and yields) is far more cost-effective than area expansion, as it requires significantly less investment per unit of additional output. This suggests that the overall agricultural development strategy should seek output growth in a manner that simultaneously increases rural employment and labour productivity, and provides for cost reductions. This could be achieved through a mix of area expansion and increases in yields, cropping intensity and stocking rates; the right mix depending on the specific conditions of each country. Area expansion should be seen as a

way to expand employment opportunities. As suggested by FAO (1988 b), increases in labour productivity should be achieved through generalized increases in yields and, particularly, through land use rates which have higher employment creation capacity. It follows that the needs are for technologies that allow for:

- cost reduction per unit of output through adapted and input responsive cultivars, and through improved crop management practices that allow for increases in input use efficiency, with particular emphasis on appropriateness for the small farm sector;

- increasing cropping intensity in fertile lands through earlier planting/maturing varieties and integrated soil, water and insect pest/disease management practices; and

- overcoming soil and other environmental constraints in selected new areas through varietal improvement and integrated crop management practices, so as to allow for the implementation of viable colonization programmes in such areas.

3.6.4. Research and Productivity

3.6.4.1. Crop Productivity

Average yields of most crops are still far below potential in most situations. Generalized and sustained increases in yield and cropping intensity can be achieved only through a combination of irrigation and improved management; chemical inputs; improved, stress-tolerant and input-responsive varieties; and improved crop management practices.

The appropriate combination of these yield-contributing factors would depend on the particular circumstances of each country, crop, growing environment and group of farmers. Since the four factors are highly interactive, as well as environment and crop specific, there are obvious advantages in conducting and integrating R&D efforts at the local level. The role of international agricultural research should be seen more as a source of improved germplasm, new knowledge, methods and principles that could be used as tools by national systems for agricultural research and extension to enhance their cost-effectiveness.

The potential for irrigation expansion is high but the cost of irrigation construction is rising in most countries. It follows that priority areas include: rationalization of irrigation policies and water tariffs, improving the management of irrigation systems, drainage and rehabilitation of saline lands, small irrigation schemes orientated towards small and medium size farms, and improving water use efficiency at the farm level. The most cost-effective strategy would depend on the particular conditions of each country. Consequently, policy and water management research needs to be conducted at the local level, except where across-border externalities are involved and thematic research to develop genetic innovations is possible.

Average fertilizer use per hectare increased considerably in the 1960s and 70s but has stagnated during the 1980s. This stagnation was caused by macro-economic difficulties, policy instability and declining crop prices. In order to reach projected production levels for the year

2000, regional fertilizer use would need to increase by 4.6% per year (FAO, 1988 b). Prevailing relative prices and demand constraints suggest that such a high growth rate might be difficult to achieve. Remunerative crop prices, policy stability and the availabiity of foreign exchange and farm credit will play a key role in determining growth in fertilizer use. This reinforces the need for increasing fertilizer use efficiency through adapted and fertilizer-responsive varieties, soil-plant nutrition research, fine-tuning fertilizer recommendations and improved soil management practices. Because of location and crop specificity, the major share of the research burden lies on the shoulders of national programmes. Areas in which economies of scale could be captured through international research include: germplasm development, methodology development, and strategic research related to "problem soils", such as acid soils, which are common throughout the region.

Chemical weed control offers an opportunity to increase yield, as well as labour productivity, in small and large farm agriculture. The need is for adaptive research to provide for environmentally appropriate and cost-effective practices. Research on integrated pest management is essential to reduce environmental risks and help reduce production costs. Priority areas include the development of germplasm resistant to insect pests and diseases of generalized economic incidence, and research aimed at facilitating the design and implementation of integrated pest management approaches by national programmes.

Banana and plantain are among the most important agricultural food and export commodities produced in the region. Only beef, milk, and coffee rank higher in terms of value of production. Banana and plantain are more important than all root and tuber crops as a group. In most of the countries, the small farm sector is increasing its participation in banana exports and shares a large proportion of the domestic market. Plantain is mostly produced by small farmers and is regarded as a staple food in most tropical areas. Production and productivity are increasingly constrained or threatened by pests and diseases, particularly black Sigatoka, Panama disease, moko and nematodes. Priority research areas include breeding for resistance to these major diseases and pests, and integrated crop management for sustainable production.

Vegetables are of increasing importance in the region, but there is a need to identify priority crops and specific research areas where international efforts have particular comparative advantages. There is also a need to understand the possible role of research in fostering the expansion of production and consumption of those vegetables that could help to alleviate mineral and vitamin deficiencies in the diet, notably iron and vitamin A, which are widespread in large subregions and in certain segments of the population.

3.6.4.2. Livestock Productivity

Livestock production and consumption is more important on a per caput basis in Latin America and the Caribbean than in any other developing region. Beef and milk alone represent between 20 and 33% of the family food budget among urban low-income groups (Muchnik and Nores, 1980). Demand for livestock products tends to grow faster than the demand for other staples. Except for commercial poultry and pig

production, and cattle production in subtropical and temperate areas, livestock productivity is well below potential. The primary outputs of cattle are meat, milk and leather. For many smallholder farmers, draught power and manure are also important outputs. The major cattle diseases include foot and mouth disease, brucellosis, and tick-borne diseases. Improved nutrition, management and health practices are all important to increase cattle productivity. To intensify production and increase animal, land and labour productivity, the key is the development of improved feed resources at the farm level. Improved pastures that allow for significant increases in stocking rates and animal performance, have a critical and catalytic role to play. An effective way to decrease pressure on tropical forest is to improve the potential of the nearly 200 milllion ha of acid soil savannas for crop, cattle and wood production. It should be recognized, however, that excessive rainfall in lowland tropical areas is a major constraint to sustainable cattle production. Because of economies of scale and high potential payoffs, international research and networking efforts should continue assigning priority to the development of improved pastures for these savanna areas. However, because of the potential implications for employment and equity, there is a need to pay increasing attention to improving the feed resource base of the small, labour-intensive, dual purpose (meat and milk) cattle operations so common throughout the tropics.

3.6.4.3. Forest Productivity

Indiscriminate deforestation is a major environmental concern in the region. This is so because of the associated problems of soil degradation, siltation of water catchments, exacerbation of flooding, desertification, increased atmospheric CO_2, loss of natural habitats of flora and fauna, and extinction of species.

The area of plantation established each year is equivalent to considerably less than one-tenth the area deforested each year. Upgrading the productivity of fast-growing species, such as Eucalyptus spp. and pines through tree improvement programmes and soil microbiology research could contribute significantly to enhanced plantation productivity and competitiveness. The needs for raw materials for the region's expanding forest industries and export trade could then gravitate more towards the plantation sector. Similarly, ensuring the supply of improved seed of multi-purpose trees and shrubs is a key for the ability of national services to secure farmers' cooperation in on-farm agroforestry research aimed at solving their own short-term needs, as well as problems with the sustainability of production. In many areas, the incorporation of trees in pastures (silvo-pastoral systems) may provide a valuable source of protein during the dry season, in addition to a number of environmental benefits, including shade for ruminants. In this respect, priority areas from a regional perspective include: the development and testing of simple experimental designs and analytical techniques for assessing the contributions of trees and shrubs to production systems in selected agroecological zones; the development of an effective seed interchange system; and improved understanding of the interactions of soil conditions and tree nutrition, including the role of fertilizers under intensive regimes for biomass production in plantations.

3.6.4.4. Fish Productivity

Fish contribute 8% of total animal protein consumption. Marine fisheries account for 95% of total production with two-thirds of the catch being processed into fishmeal. In coastal areas, fisheries provide a major source of income and employment. The region is a net exporter of fish and fish products, with fishmeal exports accounting for 45% of the world fishmeal trade. Marine catches can be expanded by more than 60% and inland capture fisheries, which account for 3.5% of total production, can be expanded five fold. Aquaculture production (177,000 tonnes) represents 1.5% of total fish production. Finfish production represents about half the aquaculture output, the other half being crustacean (mainly shrimps) and molluscs (mainly oysters) in about the same proportions. Among the finfish, carp represent 1%, tilapia 22%, trout 6% and miscellaneous freshwater species 70%. Among the latter ones, there are several native species for which there is widespread and growing interest as they command high prices in local markets. Small-scale ponds with low priced species, such as tilapia and carp are viable only in areas where supply competition (from marine and river catches and reservoir cultivation) is low. Research should focus on the development of small scale fish production systems and the improvement of nutrition.

3.6.5. Conclusions

Adoption of existing technology and known principles by national programmes can contribute to achieving output growth in the short and medium terms but, given the nature of the problems to be solved as defined by long-term socioeconomic and environmental constraints, the generation of new knowledge and technology become critical. The major burden of the efforts needed lies on national research programmes and policy analysts. From a regional perspective, however, there is considerable time to be gained and there are some obvious economies of scale that can be captured through collaborative international research on a range of problems in agriculture, forestry, capture fisheries and policy.

Finally, while investment in agricultural research and development increased considerably in the 1960s and 70s, the financial situation of most national programmes has deteriorated rapidly in the 1980s, seriously jeopardizing their effectiveness. Consequently, priority setting and the organization and management of research programmes, institutions, systems and networks are all areas that deserve increased and urgent attention at the national and regional levels.

3.7. West Asia, North Africa (WANA)

3.7.1. The Resource Base

Total population of the WANA region amounts to approximately 250 million people but is growing fast. Of the 10 countries with the highest population growth rates (between 4.1 and 5.7% p.a.), eight are located in WANA.

Of the total area (1,192 million ha), only 14% of the WANA region has a climate suited to the rainfed production of crops. Of the total

climatically suitable area (164 million ha), 86% is in the cool subtropics (winter rainfall), 8% in the cool tropics (highlands), 4% in the warm tropics and 2% in the temperate (winter rainfall) zone. Of the total climatically suitable area in the cool subtropics (winter rainfall) (140 million ha), 73% is semi-arid, 25% is subhumid and 2% is humid. The climatically suitable areas in the warm tropics, cool tropics and temperate zone are all semi-arid.

The land resources of the WANA region have been subject to considerable degradation. Many of the slopes are stony and denuded by water and wind erosion, whereas soils with considerable depth may occur in the valleys. Most of the natural vegetation is almost irreversibly lost by farming, grazing, fuelwood collection and other forms of exploitation which, combined with mismanagement of the soil for crop production have also led to irreversible desertification in the semi-arid and arid zones. Saline soils present another serious problem, especially in many irrigated areas. The length of the growing season together with temperature determines, to a large extent, the potential suitability for various crops, improved pastures and rangeland. The length of season on rainfed land varies from zero to more than 200 days. It is determined by rainfall level and distribution, the depth and texture of the soil, and the pattern of run-on and run-off.

Of the total land area, over 800 million ha are desert-like, 100 million ha are arable land, 270 million ha are used as permanent pasture and rangeland, 25 million ha are classified as forests and 8 million ha are covered with permanent crops. Of the arable land, 40% is at higher elevations, whereas 19% is irrigated land. There is little scope for extending the area of rainfed arable land, but the potential surface that may be irrigated without excessive investments is estimated to be 35 million ha. Expanded irrigation has considerable potential to increase food production in the region but salinity is a serious risk. In some countries, careful attention must be given to the conservation of groundwater reserves. There are 200 million sheep and goats, 40 million cattle and buffalo and 15 million horses, mules, asses and camels in the region, producing approximately 3 million tonnes of meat a year. Fish production amounts to almost 2 million tonnes annually, valued at US$ 1 billion, and originates for 80% from marine capture fisheries, and about 16% from inland capture fisheries, with the remainder from culture fisheries. There is scope, however, for further development of culture fisheries. Marine fisheries are particularly important in Morocco and Turkey.

3.7.2. Economy

Three groups of countries may be roughly distinguished in the region.

- Oil exporting countries: Algeria, Baharain, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia and the UAE; in the middle of the eighties their total population was 120 million and their average GNP 2,500 US$ per caput per year; their yearly growth rate during the boom of the seventies was about 10%.

- Labour exporting countries: Egypt, Jordan, Lebanon and Yemen with a population of 70 million, a GNP of US$ 800 per caput per year and a yearly total growth rate of 6%.

- Countries in which food production is the dominant economic activity: Afghanistan, Cyprus, Israel, Morocco, Syria, Tunisia and Turkey with a population of 105 million, a GNP of US$ 1,250 per caput per year and a yearly growth rate of 2.5%.

The region encompasses extremes, with Afghanistan on one side with 17 million people and a per caput income of US$ 250 per year, and Qatar on the other side with 0.3 million people and a per caput income of US$ 16,000 per year. The annual growth rate of GNP varied in the middle of the eighties from -5% to 5%. The lowest growth rates may be attributed to the ravages of war. Barring further turmoil, the GNP is expected to increase on the average at about 4% per year. About 50% of the population is urban, with a low of 15% in Afghanistan and North Yemen and a high of about 80% in the oil states. The average contribution of agriculture to the GNP is 25%, but it varies from a negligible proportion in the oil states to 35% in the Yemens.

As recently as 1950 the WANA region was a net food exporter, but the region now depends heavily on imports of wheat and barley, food legumes and milk and meat products. There are large food subsidy programmes in some countries, but increasing amounts of grain imports are also used as feed. At present, imports of wheat and barley amount to 30% of the total supply of 100 million tonnes per year. The food gap in the WANA region may very well double by the year 2000. This is partly attributable to continuing increases in population, incomes and the consumption of livestock products, and partly to the low population supporting capacity of the region, which is smaller than its year 2000 population even at intermediate input levels.

The oil and labour exporting countries in the region may face labour shortages in their peak seasons owing to migration of labour both to urban areas and to oil-rich countries. The acute shortage and high cost of agricultural labour are further aggravated by intensification of production. The opportunity costs of labour can no longer be regarded as low, which leads to mechanisation and larger farm sizes.

5.7.3. Agricultural Development

Although there are exceptions, such as in Afghanistan, large parts of WANA are characterized by: (i) an increasing income from diversifying economies or from oil which, on the average, exceeds the increase in population; (ii) rapid urbanization and migration of labour over international borders; (iii) increasing opportunity costs of labour in agriculture; and (iv) such a small agricultural resource base that considerable agricultural imports remain necessary to meet increasing and changing demands.

Under such circumstances, agricultural development will be characterized by: (i) further commercialization; (ii) intensification and mechanisation; (iii) increased emphasis on production of commodities that suit urban needs and have a large added value; and (iv) decreasing importance of traditional, resource poor, small-scale farms.

3.7.3.1. Irrigation Systems

Such developments would favour increased production from irrigated land, both by expanding the area under irrigation and by increasing cropping intensity and yields. However, FAO expects only modest increases, because inadequate water management combined with insufficient drainage may continue to lead to increased salinity and waterlogging. This results not only in the loss of land, but also in decreasing yields, such as in some parts of Egypt, Iraq and Syria. Other countries are affected by depletion of groundwater and seasonality of the water supply. Because of such factors, the accent has to be on increasing productivity by raising the technical and economic efficiency of agriculture.

The cropping pattern on irrigated land in WANA may very well change further in the direction of vegetables, fruits and flowers to meet increasing internal demands for these products by urban dwellers, and to serve export markets. Their importance in WANA is reflected by the fact that the production of vegetables in the Near East of 136 kg per caput per year, exclusive of roots and tubers, is well above the production in Western Europe and North America.

Rice and wheat straw, cotton seeds and other by-products are widely used in animal husbandry. The market for milk and milk products is also rapidly expanding and part of the irrigated land may very well be used to grow high quality forage (berseem in Egypt) for intensive dairy farming, while the forage required to maintain animal traction will decrease as a result of mechanization.

Increasing crop yields and increasing cropping intensities have to be sustained by a more or less proportional increase in the use of fertilizer. Increased efficiency of its use would reduce the costs for the farmer, decrease the risks of salinization and pollution, and lessen food supply constraints. An over use of biocide on irrigated cotton may have the unintended advantage that a firm knowledge base is obtained for the development of integrated insect pest and disease management. This may be the more needed because the incidence of some insect pests and diseases is likely to increase with increasing yields and cropping intensities.

3.7.3.2. Rainfed Systems

The rainfed areas are mainly exploited by farming systems based on wheat and barley. A large part of barley production is used as livestock feed. The bulk of farm income is from the sale of sheep and their products, while grain, straw and forages are used as feeds to supplement pasture grazing and browsing the steppe. In the wheat-based systems part of the income is derived from bread-wheat and pulses. These systems require more moisture, with the result that legumes associated in the system also do better. Under favourable conditions, the arable land is increasingly used for the cultivation of horticultural crops and orchard trees. Otherwise, these grain-based farming systems are further integrated with livestock farming to improve the offtake of the large number of livestock in the WANA region.

With increasing primary production associated with better management and the use of fertilizers, the variation in yield from year

to year will increase. This may be buffered by selling grain in good years, buying imported feeds or quality forage from better regions or irrigated land in bad years, and motorized transhumance to exploit the large local differences in rainfall. Intensification and commercialization are thus closely intertwined. The output of these wheat and barley based systems may very well increase by 2-3% per year.

The production systems at higher elevations are similar to those in the lowlands. However, agriculture in these highlands is even more heavily orientated towards raising livestock and growing cereals, where responses to improvements are smaller. In the countries that are classified as oil and labour exporting, part of the population of the highlands is enticed to migrate, to such an extent that the remaining part of the population may be able to increase their labour productivity by enlarging their enterprises. However, in the countries that are classified as food producing, the populations of the highlands tend to be more isolated and have fewer employment options.

3.7.4. Forests and Rangelands

Deforestation in the Mediterranean region has been going on for centuries and not more than 25 million ha of closed forests remain (the lowest of all four regions). The main pressures on forest resources have been grazing, fuelwood harvesting and expansion of the agricultural land area.

Palatable shrubs form an essential component of the food in rangelands. They may extend the grazing season and help to reduce the impact of erosion, especially under circumstances where it is impossible to maintain perennial grasses. Moreover, they are often the main productive component in sheep husbandry systems. However, due to overexploitation, much of the palatable woody vegetation in the rangelands of the region has been removed or replaced by unpalatable shrubs.

In Iran, Israel, Jordan and Syria it has been demonstrated that regeneration of overexploited rangeland is possible by controlled grazing and technical means such as contour furrowing, construction of microcatchments, reseeding of perennial and annual grasses and legumes, protecting seedlings of woody perennials, and removal of unpalatable species. The wider application of such approaches is very much related to socio-economic policies that will provide improved incentives for farmers and communities to adopt improved methods of farming and soil conservation.

As in sub-Saharan Africa and upland Asia, a high research priority for the region is increasing the productivity of selected higher yielding fodder trees and shrubs. Development of salt tolerant and/or drought resistant species for the reclamation of agricultural wasteland is particularly important.

3.7.5. Conclusions

The productivity of agriculture, fisheries and forestry in the WANA region is likely to continue to increase, but it is extremely unlikely that this will occur to such an extent that the region will be

able to grow all its own food and forestry products. However, there are so many other opportunities for trade that, for most countries, the prospects for self-reliance are good.

The implications of this conclusion for future research are that it should primarily be directed towards income generation. In the resources area, research is needed on technologies to combat land degradation and, in irrigated areas, research is needed on irrigation management to reduce salinity problems.

CHAPTER 4 - NEED FOR INTERNATIONAL RESEARCH

4.1. Introduction

Previous sections of this report have illustrated the challenges to agricultural, fisheries and forestry research from both a global and a regional perspective. Agricultural research priorities in the past have generally focused on the role of agriculture in food supply. Agriculture however also has many other contributions to make which must be considered in setting priorities for the future. Increases in food production will be a necessary but not a sufficient condition for sustained economic and agricultural development. Poverty alleviation and a reversal of environmental degradation will require a substantial effort on a much broader front. Considerations on a possible expansion of the CGIAR have to take these changing priorities into account.

Malnutrition, poverty, food supply, sustainability and conservation of natural resources have been identified as the most critical problems that will be faced by the global agricultural research system during the coming decades. The information provided in Chapter 3 has pointed to the major constraints that prevent the solution of these problems in each of the regions. The next step is to identify how these constraints can be relaxed by research or by policy changes. Chapter 4 therefore deals with the need for international research. In this respect it is important to clarify the special nature of that research. This is discussed in Section 4.2., while Section 4.3. presents a discussion of national science capacity. Section 4.4. draws together an inventory of identified needs for international agricultural, fisheries and forestry research. Finally, Section 4.5. provides an overview of international and regional scientific capacity for developing countries.

4.2. The Special Nature of International Research and Related Activities

International efforts have special advantages in a number of research areas and in several activities supporting and servicing research. Agro-ecological environments do not stop at national, nor indeed continental boundaries. Plant materials tolerant to acid soils are potentially useful wherever acid soils are found and the principles of managing vertisols are relevant whether the soils are located in Africa or the Indian sub-continent. In planning and determining priorities in international research, consideration will be given to the maximization of spillover effects that will result from research activities. Over the longer term, supranational rationalization of a good deal of research is a logical goal, with significant savings for participating, partner nations. The CGIAR can perhaps be seen as a start to such a global research system.

Currently weak national research systems demand more activities at the international level than eventual comparative advantage will dictate. Two types of activity are distinguished:

A. **Activities with a Continuing Comparative Advantage at the International Level.**

These include:

- assessing the changing research needs of global agriculture, fisheries and forestry
- the collation and dissemination of scientific information
- the collection, preservation, and exchange of germplasm and improvement of methodology for utilizing germplasm
- the development of germplasm for crops, fish and animals dominant in the economic activity of many countries
- the development of resource management and husbandry principles appropriate for agroecological circumstances widely distributed around the globe
- strategic research on production processes
- specialized manpower training.

The larger developing countries will eventually have capability in these areas. However, the large number of small developing countries will remain unable to undertake the overhead investments in research facilities and specialized, higher education. Several may be handled through strong outward looking national programmes and the effective networking of information. For others a continuing international effort will be justified.

B. **Activities justified over the Medium Term by the Current Lack of Capacity in the Developing Countries.**

These include:

- training at several levels of manpower required in research: managerial, scientific and technical
- assistance in institutional and manpower development
- assistance in priority setting and in research strategy and programme formulation
- bridging from the basic and strategic research of the industrial countries to meet the needs of the developing countries
- methodology development and training in its application
- technical assistance and financial aid for in-country applied and adaptive research often through bilateral programmes.

The need for international involvement in these Type B activities will continue for many years though there is no inherent comparative advantage for these activities at an international level. The need for

direct support differs from country to country and region to region. China and India are increasingly capable in research, while at the other extreme national systems in Africa remain particularly fragile.

4.3. The Evolution of National Scientific Capacity in the Developing Countries

A factor of paramount importance in changing international research priorities is the evolution of scientific capacity in the developing countries themselves. The international community acknowledges national research systems as the foundation of a global system, serviced by the supranational levels.

4.3.1. The Status of National Agricultural Research

Public sector agricultural research investment in developing countries has increased substantially in the period 1960-64 to 1980-85 (Table 4.1.). In the former period developing countries accounted for only 21% of the global number of full-time equivalent researchers, and 24% of real research expenditures. By 1980-85 these shares had risen to 45% and 35% respectively (Pardey and Roseboom, 1988).

In terms of the numbers of agricultural research scientists, the four developing regions have been growing at much the same rates over the past 25 years. However, the Asia/Pacific and Latin America/-Caribbean regions have been growing much faster than sub-Saharan Africa and WANA in terms of real dollar agricultural research expenditures. Unfortunately, with the exception of Asia, expenditure per scientist in developing countries has fallen since the early 1970s. This suggests that operating and capital funds available for scientists have become more of a constraint in the past 10 years or so in all regions except Asia.

The data in Table 4.1. show that the Asian/Pacific and Latin American/Caribbean regions devote the largest amounts to agricultural research. However they also have larger agricultural sectors than the other two regions. To place these absolute research investments in perspective, it is helpful to express them as a percentage of each region's agricultural gross domestic product (Table 4.2.)

Care has to be taken in the interpretation of these figures however. Simply because the Asian/Pacific region turns out to have the lowest research intensity, it would not be appropriate to conclude that it has the weakest agricultural research capacity and productivity, or contrariwise that sub-Saharan Africa has the strongest. Nor can we infer that the 2% research intensity of developed countries should be emulated by developing countries. Qualitative assessments of informed and experienced research managers should accompany perusal of quantitative information of this type.

4.3.2. The Status of National Forestry Research

Investment in research on forestry and forest products in developing countries have been relatively small. FAO has prepared a list of 538 organizations in developing countries that are formally

Table 4.1. Trends in National Agricultural Research a/

Region	1960–64	1965–69	Years 1970–74	1975–79	1980–85	Ratio 1980–85/ 1960–64
			TOTAL NUMBER OF SCIENTISTS			
Dev'g Countries	10477	15588	22684	33816	45182	4.3
sub-Saharan Africa (43) b/	1159	1682	2242	3321	4870	4.2
Asia/Pacific (28) c/	5123	7943	10639	17379	22625	4.4
WANA (20)	2100	3134	4506	6514	8967	4.3
Latin America/ Caribbean (38)	2095	2829	5297	6602	8720	4.2
Developed Countries	39097	43668	47326	50498	54488	1.4
			REAL RESEARCH EXPENDITURES d/			
Dev'g Countries	649	1013	1618	2179	2546	3.9
sub-Saharan Africa	121	203	267	348	382	3.2
Asia/Pacific	238	395	599	811	1106	4.6
WANA	111	163	305	363	344	3.1
Lat.America/Car.	179	252	447	657	714	4.0
Developed Countries	2022	2955	3657	4090	4717	2.3

a/ Source: Pardey and Roseboom (1988).
b/ Figures in parentheses refer to the number of countries included.
c/ Excludes the Peoples Republic of China.
d/ Measured in millions of 1980 US$ using purchasing power parity exchange rates. Measures actual research expenditures (salaries, operations and capital) as opposed to appropriations and includes the public sector and private non-profit agricultural research. It excludes foreign-funded/ executed research in collaboration with national agricultural research agencies. Includes expenditure on pre-harvest research on crops, livestock, forestry and fisheries but excludes research applied at the post-harvest stage. Development-financed research integrated into existing agricultural research infrastructure is included where it was possible to isolate the research components of such projects. Note these data refer to only 129 of the 154 countries included in the total indicator series compiled by Pardey and Roseboom (1989). The result is an underestimation of total and regional volumes.

Table 4.2. Agricultural Research Intensity Ratios (1980-85) 1/

	Number of Countries Included	Agriculture Research Intensity (%) 2/
Sub-Saharan Africa	41	0.54
Asia/Pacific (excl. China)	21	0.34
West Asia/North Africa	20	0.43
Latin America/Caribbean	34	0.54
DEVELOPING COUNTRIES	116	0.42
DEVELOPED COUNTRIES	21	2.01

Source: ISNAR (Private Communication)

1/ Real research expenditures as % of agricultural GDP.

2/ Agricultural research expenditure figures are from Pardey and Roseboom (1989).

involved in tropical forestry research, of which 45% can be found in Latin America and Caribbean, 36% in Asia and the Pacific, 14% in Africa and 5% in the Near East (FAO, 1986 b). Many of these organizations only have a few staff, sometimes not even scientists, and more detailed information is available on only 238 (or 44%) of these. National/-provincial public research bodies (107) make up almost half the total, while universities (67) provide the second largest category and forestry services branches (37) were third in importance. Only a few agricultural research institutes (9) or private bodies/development projects (18) carry out research on tropical forestry. A majority (62%) of these organizations engage in forestry research only, with the remainder engaging either in forestry products research only (12%), in a mixture of forestry and forest product research (19%), or in other activities (7%). It is important to note, however, that some forestry research (for example on topics such as nitrogen fixing trees) is done by non-forestry research organizations.

FAO has estimated that, in the organizations for which information was available, the total numbers of forestry research scientists in developing countries amounted to 6,716, of which 53% were located in Asia and the Pacific, 32% in Latin America and the Caribbean, 11% in Africa and 4% in the Near East (FAO, 1986 b).

Expenditure on forestry research in developing countries in 1981 amounted to US$ 186 million, of which 60% was allocated in Asia, 21% in Africa and 19% in Latin America (Mergen et al., 1988). Although more recent data are not available, if past trends are an indication, current annual expenditures are likely to be in excess of US$ 200 million.

Developing countries account for only 12% of total investment in forestry research worldwide. Available estimates indicate that forestry research intensity in developing countries is considerably less than one-tenth of agricultural research intensity. Forest research expenditures as a percentage of value of production have been estimated at 0.019 for low-income developing countries, 0.059 for middle-income developing countries and 0.070 for semi-industrialized countries. The corresponding ratios for agriculture research expenditures as a percentage of production were estimated at 0.451, 0.863 and 0.816 respectively (Mergen et al, 1988).

4.3.3. General Assessment of National Science Capacity in Agriculture and Forestry

The overall picture is of national research systems gaining scientific capacity. This general trend masks stagnation and even decline in some countries and major advances in those where governments have an increased awareness of new agricultural technology as the engine of economic development. Often, government support to national research services is erratic, or plainly inadequate. Many scientists in developing countries are badly paid in comparison to salaries in other sectors of the economy, their working facilities are inadequate and equipment is often poorly maintained. Intellectual isolation is a common problem and researchers usually have few career opportunities. In consequence, national research services frequently operate at substandard levels.

Assessment of developing country scientific capacity is difficult. Indicators are often based on the upward trends in the numbers of scientists and government funds, and by the proportion of GDP allocated to research. These fail to measure the effectiveness of the research system. A number of commentators have pointed out that the managerial capacity of many developing country research organizations is too low to effectively absorb funds and scientists. At the same time the upgrading of scientists by graduate work has frequently had to be done overseas and is often heavily dependent on donor funding. In the case of sub-Saharan Africa in particular, ISNAR case studies have shown recurrent budgets dominated by salaries with very little money available for research programmes per se. This, together with late notification of what is available and highly variable amounts from year to year, has led to low morale among scientists and high rates of staff turnover. Thus, a sheer increase in research budgets and staff numbers may be misleading.

There is wide variation in the size and quality of developing country research services. Many countries have good capacity to undertake research in fields such as crop improvement and crop protection, but in fields such as natural resource management and conservation, or social science research, research capacity often remains weak. At one extreme limited Type A services will be demanded by advanced national research systems. At the other, countries with young national systems may seek both technical assistance and funding to enhance domestic capability.

This diversity complicates the task at the international level of the global system. Efforts must be balanced between research and the development of national systems capacity. At the same time both the

international and national levels must embrace changes in science and monitor the dynamics of national and global research demands in establishing their priorities.

4.4. Needs for International Research

4.4.1. Background

The information provided in the previous sections and chapters of this report have provided TAC with insights leading to a list of international research needs presented in Table 4.3. (pages 54-62). The latter represent an identification of international research needs, which are grouped under the heading of major research or research-related categories. They are largely similar to the categories developed by TAC in its most recent review of CGIAR Priorities and Strategies (TAC/CGIAR, 1987). New categories for forestry and fisheries have been added to facilitate the classification of emerging international research needs in these areas. The listing of international research needs is presented by region. A cross (x) indicates that within that region there is a very strong demand for that particular research activity which merits international support. The list was derived from the information provided in Chapter 3 augmented by TAC's collective judgement. This list of research needs, drawn up from an international perspective, has been prepared irrespective of the actor in the global research system best placed to meet those demands. TAC acknowledges that this list is indicative only of the broad trends in demand for international agricultural research. In order to provide operational guidelines for setting priorities in resource allocation, further disaggregation of these needs by agroecological zone and by commodity would be necessary. The particular role of the CGIAR in meeting some of these needs will be addressed in further chapters of this report.

4.4.2. Resource Conservation and Management

The combined impact of increasing population pressure and resource degradation described earlier points to the need for a broadening of the emphasis in internationally supported research to give greater weight to issues of resource conservation and management. Research needs in this area include for example: investigation of global environmental concerns; development of methods for ecological characterization; conservation and evaluation of germplasm of plant and animal species of regional and global importance; improved understanding of natural forest ecology and management; natural fisheries ecology and management, including management models for sustainable development; soil conservation and management with special emphasis on better understanding of the long-run nutrient economy of tropical soils under increasing cropping intensity, with due consideration for trace element deficiencies in human and animal nutrition; better understanding of farmer decision-making under conditions of increasing land scarcity; development of principles and methods for management of water resources for irrigation and rainfed systems; and land-use management and development of production systems. Emerging as a common theme from all the regional overviews is the message that continued emphasis on research topics aimed at increasing commodity productivity (including fuelwood) could make a significant contribution to the sustainability of resource management and land use.

4.4.3. Crop Productivity Research

In crop production research the emerging needs show a complementarity with the areas highlighted under resource conservation and management. Increased emphasis on management, and the exploitation of existing potential, promises a new balance with crop improvement in the future CGIAR. The main demand for international research relates to germplasm enhancement and breeding.

The areas in crop productivity research needing reinforcement recognize the small farmers' needs for low cost techniques, for cost saving changes and for the means to exploit the marginal areas into which they are driven. Major efforts are indicated in the field of fertility maintenance both with increased recognition of the role of organic manures from plants and animals in sustainable production, and the need for improved rotational cropping systems complementing the use of fertilizers. Emphases on research in tillage, planting and weed control recognize the low power resources of the small farmer and the important role of timeliness in crop management for higher yields. There is also a strong demand for research on pest management. Breeding work for resistance to, or tolerance of, biotic and abiotic stresses, and further emphasis on stability through mixed enterprise systems and through intercropping, will be important to farmers operating under uncertain rainfall conditions. The need for selection for yield potential and for quality is strong throughout the developing world. There is also a major demand for research on plant nutrition and on seed technology and production.

4.4.4. Livestock Productivity Research

Within the livestock sector the analysis emphasizes the importance of research on animal nutrition across the regions and on the development of breed improvement strategies appropriate for smallholder production systems. A strong demand for research on animal health has also been identified, particularly with respect to tsetse-borne, tick-borne and reproduction diseases. There is also a need for research on endoparasites in ruminants. Improved constraint analysis with respect to reproduction, and the development of approaches for herd and flock management under increasing pressures of land and forage resources require particular attention in Asia and sub-Saharan Africa.

4.4.5. Fish Productivity Research

With respect to resource conservation and management, in all regions there is a need to further develop and validate models for management of capture-based fisheries, especially for coastal and shallow water areas. Priority areas in fish productivity research include studies on fish nutrition, particularly the nutritional requirements of cultured aquatic species, the nutritional constraints in extensive and semi-intensive systems, and the development of alternative feedstuffs. The development of appropriate fish production systems is of particular relevance to Asia, but with spillover potential for other regions. Such studies should focus on pond productivity and nutrient dynamics, especially in semi-intensive systems, and on the carrying capacity of open aquatic systems. Improving germplasm and maintaining the quality of stocks of key species is also a priority area. There is

a need for constraint analysis on pests and diseases and for studies on seed propagation methods. In Asia and sub-Saharan Africa there is also a need for research on aquaculture engineering, particularly on fish-farm design and on cages, pens and other enclosures, but the role of public international research in this requires further definition. High priority should also be given to understanding human health hazards in fishing systems, and to the development of fish processing/ preservation techniques. Policy analysis and research on institutional systems are also important. Emerging environmental issues of regional concern are the impact of coastal pollution and destruction of mangrove forests on fisheries production.

4.4.6. Forest Productivity Research

Emerging research needs in forestry reflect growing concern in all regions about the impact of deforestation on agricultural productivity, water supplies, fuelwood, fodder, climate and sustainability of wood supplies. There are good prospects for increasing productivity of multi-purpose trees via tree improvement programmes. There is a pressing need for research on sustainable management of tropical forests for a variety of products and services and as a deterrent to the present trends towards depletion of resources including deforestation. Agroforestry research, especially to quantify the potential of trees and shrubs to contribute to crop/livestock productivity is particularly relevant to sustaining output from marginal soils under situations of increasing population pressure. There is also a strong need for an improvement in the data base for forestry resources and their use.

4.4.7. Commodity Conversion and Utilization Research

At the international level, there is a clear need for research on post-harvest technology in crop, livestock and fish production. A similar effort is required for forestry products. Utilization research will contribute to more intensive management of forest resources and conservation of threatened species.

4.4.8. Research on Human Linkages

Increased food production alone will not necessarily improve human nutrition and family well-being. In order to identify those at greatest risk, there is an urgent need to develop a data base on food consumption patterns of the rural and urban poor, and to identify low-cost, efficient indicators of malnutrition for development and evaluation of agricultural programmes. Such data can be utilized to assess the implications for human nutrition of strategies for income generation through agricultural development. Nutritional considerations should be an integral part of commodity improvement programmes, including investigation of the effects of alternative production methods of technical change and alternative agricultural strategies on the nutritional quality and safety of food. Attention should also be given to gender issues, a better understanding of human disease hazards and links to socio-cultural organization and farming systems.

4.4.9. Socioeconomic and Policy Research

In the area of socioeconomic and policy research an emerging item from all the regions is the need for more intensive policy research to assess the underlying causes of environmental degradation processes and the potentials for reducing those causes through policy reforms. Policy reforms in such areas as land tenure, agricultural and timber taxation, pricing policies and adjustment to pesticide and fertilizer subsidies are frequently the key to slowing down natural resource degradation and to increased investment in land reclamation and sustainable resource management. Attention should also be given to studies on poverty alleviation and market analysis, as well as the economic and social analysis at the micro level.

Ex post studies and methods for ex ante assessment of expected impact are identified as important for priority setting at both the national and international levels. Beyond this, exploration of methods for analysis of these issues demands increased attention.

4.4.10. Institution Building and Research Related Activities

At the other end of the scale, given the ultimate local specificity of resource and crop management problems, building capacity in national research institutions to diagnose problems, to plan and interpret resource and crop management research and to adapt solutions, are all prerequisites to success in farmers' fields. Training, counselling and networking in these new substantive areas need expanding. Improving the organization and management of national research and development systems deserves continued international support.

4.5. International and Regional Scientific Capacity for Developing Countries

The global agricultural research system provides a framework for a discussion of the different sources of scientific capacity to meet the research needs of the developing countries. Four levels of research effort can be identified; the national systems, country-based transnational and regional groupings, international research at the regional and global levels and the advanced institutes of the developed countries and the larger developing countries. With its existing programmes and organization the CGIAR draws from the advanced institutes and contributes at each of the other levels. This pattern is likely to continue.

The CGIAR is not the only actor at the international and regional levels or the only contributor to the national and transnational levels. Many other international agencies and regional institutions make important contributions. At the international level FAO, UNESCO, IAEA, UNEP and smaller agencies such as CABI, WRI, and IUCN, are examples of bodies of different types which make broad contributions. Other, smaller initiatives, such as ICIMOD, TROPSOILS, IBSNAT and the USA-sponsored CRSPs work on specific areas following various organizational formats. CATIE is an existing centre at the regional level with both country and international support. Transnational initiatives have been established in Latin America providing for

regional collaboration in research, PROCISUR made up of the countries of the southern cone, and PROCANDINO, made up of countries touched by the Andes are two examples. CARDI in the Caribbean is a further example of a multi-country initiative for regionally important research based in national programmes. Similar transnational initiatives have recently been established in Africa with organizations such as SACCAR, the agricultural research committee of the SADCC countries, and CORAF, a networking organization initiated in the francophone countries, the best known.

Two factors justify a long-term role for the CGIAR as an international body for agricultural research. The first is the enduring economic rationale for permanent global research at the strategic level in both germplasm development and ecosystem management. The second stems from the analysis of the existing situation among national agricultural and forestry research systems in developing countries. This demonstrates the need for continued capacity building. Given the current lack of political commitment in many developing countries to research as the basis for agricultural development, this need is likely to remain beyond the medium term. Indeed, groups of smaller countries, particularly in Africa, may never be able to justify the cost of their own research organization and will remain borrowers of technologies. The CGIAR has proved itself a highly effective capacity building agency; both the training efforts of the crop, livestock and resource management programmes at the CGIAR centres, and the specialized institution building capabilities of ISNAR are widely appreciated across developing countries.

Table 4.3. List of International Research and Related Needs

	ASIA	SSA	LA/C	WANA
I. RESOURCE CONSERVATION AND MANAGEMENT				
1. Global environmental concerns (research on selected aspects)				
- Effects of environmental changes on agriculture, forestry and fisheries	x	x	x	x
- Effects of the management of natural resources on the global environment	x	x	x	x
2. Ecological characterization				
- Methods for ecological characterization and zoning in relation to existing farming systems and forestry, fisheries, and potential land/water uses	x	x	x	x
3. Germplasm conservation and evaluation				
- Plant, animal, and aquatic species of regional and global importance	x	x	x	x
4. Natural forest ecology and management				
- Improved understanding of climatological and biological role of tropical forest ecosystems	x	x	x	
- Development of management principles for sustained yields of wood and non-wood products in forests and agricultural options	x	x	x	x
- Application of remote sensing methods to improve quantification of land use change with special reference to deforestation	x	x	x	x
5. Natural fisheries ecology and management				
- Development and validation of models for management of capture-based fisheries	x	x	x	x
- Application of remote sensing methods to improve quantification of fisheries stocks	x	x	x	x

	ASIA	SSA	LA/C	WANA
6. Soils conservation and management				
- Development of techniques for increased production by small farmers in Vertisol areas	x	x	x	x
- Development of appropriate tillage methods for soil, water and power conservation	x	x	x	x
- Understanding the long run nutrient economy of tropical soils under increasing cropping intensity	x	x	x	
- Better understanding of the chemistry and management of acid soils in the tropics	x	x	x	
- Research on the clearing and sustainable management of cleared forests and woodlands	x	x	x	
7. Water conservation and management				
- Development of principles and methods for sustainable management of water resources (including drainage)				
— irrigated systems	x	x	x	x
— rainfed systems	x	x	x	x
8. Land use management				
- Research to understand multiple and competing land use options for:				
— watersheds	x	x	x	x
— coastal areas	x			
— rangelands		x	x	x
9. Development of production systems for sustainable resource management				
- Development of testing of cost-effective methods for assessing the contribution of trees and shrubs to production systems	x	x	x	x
- Development of management principles for agroforestry systems				
- Multiple systems for crops/livestock/trees	x	x	x	x
- Multiple systems for crops/livestock/fish	x	x		

	ASIA	SSA	LA/C	WANA
II. CROP PRODUCTIVITY RESEARCH				
1. Germplasm enhancement and breeding (including use of biotechnology)				
- Development of adaptation, tolerance and resistance to biotic and abiotic stresses for important crops	x	x	x	x
- Selection for yield potential	x	x	x	x
- Selection for quality:				
— food	x	x	x	x
— feed	x	x	x	x
2. Crop systems				
- Sequencing, mixing, intercropping principles	x	x	x	x
- Tillage, planting and harvesting systems	x	x		x
3. Plant protection				
- Biology and ecology of main pests	x	x	x	x
- Components for pest management for main crops				
— Identification and evaluation of biological control agents	x	x	x	x
— Other components for pest management	x	x	x	x
- Inter-relationships among components	x	x	x	x
4. Plant nutrition				
- Understanding interactions of nutrients/ microbiological processes for designing simple methods for improved nutrient use efficiency	x	x	x	x
5. Seed technology and production				
- Development of methods for smallholder seed production to enhance adoption of improved cultivars	x	x	x	

	ASIA	SSA	LA/C	WANA
III. LIVESTOCK PRODUCTIVITY RESEARCH				
1. Germplasm enhancement and breeding				
- Development of breed improvement strategies appropriate for smallholder production systems				
— Identification and multiplication of disease and pest resistant animals	x	x	x	
— Introduction and evaluation of superior sheep and/or goat breeds	x	x		x
— Evaluation of crossbreeding systems	x	x		x
2. Livestock systems				
- Herd and flock management under increasing pressures on land and forage resources	x	x		
3. Animal nutrition and feed				
- Improvement of the feed resource base				
— fodder crops, pastures and shrubs	x	x	x	x
— crop residues and by-products	x	x		x
- Strategic feed supplementation	x	x	x	x
4. Reproduction				
- Identification of critical constraints to improved reproduction	x	x		
5. Animal health; identified priorities, e.g.:				
- Tsetse-borne diseases		x		
- Tick-borne diseases	x	x	x	
- Reproduction diseases	x	x	x	x
- Endoparasites in ruminants	x	x	x	x
IV. FISH PRODUCTIVITY RESEARCH				
1. Germplasm enhancement and breeding				
- Improving germplasm of key species	x			
- Maintenance of quality of stocks of key species	x	x	x	

	ASIA	SSA	LA/C	WANA
2. Fish production systems				
- Pond productivity and nutrient dynamics, expecially in semi-intensive systems	x	x		
- Carrying capacity of open aquatic systems	x		x	
- Recruitment enhancement	x	x	x	x
3. Fish nutrition				
- Nutritional requirements of cultured aquatic species	x	x	x	x
- Nutritional constraints in extensive and semi-intensive systems	x	x		
- Developing alternative feedstuffs — Critical amino and fatty acids	x		x	x
4. Reproduction				
- Methods for propagation of seed by natural and artificial breeding	x			x
- Reduction of disease transmission through seed distribution	x			
5. Pests and diseases				
- Constraint analysis on pests and diseases	x	x	x	x
- Studies on control of disease in aquatic species	x	x		x
6. Aquaculture engineering				
- Fish farm design	x	x		
- Cage, pen and other enclosures	x	x		
V. FORESTRY RESEARCH				
1. Germplasm enhancement and breeding (including use of biotechnology)				
- Selection (including clonal propagation and tissue culture where appropriate) of selected multi-purpose species	x	x	x	x

	ASIA	SSA	LA/C	WANA
- Exploratory research on genetic resistance to biotic and abiotic stresses and on selected areas of pathology/entomology	x	x	x	
- Biological processing of wood wastes and non-wood products for economic use	x	x	x	
2. Forest systems and establishment methods				
- Development of data base	x	x	x	x
- Methods and principles of intensive biomass forestry, with emphasis on fuelwood and fodder	x	x	x	
- Afforestation techniques for wasteland reclamation	x	x	x	x
3. Tree nutrition				
- Understanding soil organic matter and soil microbiology/tree interactions in major agroecological zones, with emphasis on seedling survival, enhanced yield and improvement in nutrient use efficiency	x	x	x	x
4. Forest products				
- Minor products from natural forests; farm and community tree outputs	x	x	x	
VI. COMMODITY CONVERSION AND UTILIZATION RESEARCH				
1. Crops				
- Post-harvest technology	x	x	x	
2. Livestock				
3. Fish				
- Development of fish-processing and preservation techniques	x	x		
4. Forest products				
- Assessment studies on efficiency utilization of biomass	x	x	x	
- Utilization research for making better use of presently non-commercial timber species	x	x	x	

	ASIA	SSA	LA/C	WANA
VII. RESEARCH ON HUMAN LINKAGES				
1. Analysis of human nutrition				
- Development of data base on food consumption patterns of the rural and urban poor and on the nutritional composition of foods (incl. micronutrients and antinutritional factors, potentially toxic), in order to identify nutritional risks	x	x	x	x
- Development of reliable, cost-effective, rapid indicators of malnutrition for agricultural programme development and evaluation	x	x	x	x
- Investigation of the effect of alternative production methods of technical change and alternative agricultural strategies on the nutritional quality and safety of food	x	x	x	x
2. Other linkages				
- Understanding of general gender issues	x	x	x	x
- Understanding of human disease hazards from:				
— fish production systems	x	x		
— irrigated agriculture	x	x		x
— crop, animal, water and pesticide management implications as they relate to human health (including use of manures in aquatic systems)	x	x	x	x
— aquatic environmental pollutants from non-farm sources	x		x	x
- Socio-cultural organization and farming systems				
— use rights	x	x	x	x
— harmonization of use of scarce resources	x	x		
— risk management strategies	x	x	x	
— mechanisms and institutions for cooperation at community level	x	x	x	
VIII. SOCIO-ECONOMIC AND POLICY RESEARCH				
1. Economic and social analysis at micro level				
- Development and testing of cost-effective methodology for participatory research into production systems and their nutritional consequences	x	x	x	x

	ASIA	SSA	LA/C	WANA
- Modelling of technology and policy options for smallholder production systems	x	x	x	x
2. Market analysis				
- Aggregate commodity supply and demand trends	x	x	x	x
- Structure and functioning of poorly understood input and product markets, e.g.				
— fuelwood and substitutes	x	x	x	
— livestock products		x		x
— fish and fish products	x	x		
— fertilizers	x	x	x	
— roots and tubers	x	x	x	
3. Policy analysis				
- Assessment of alternative development strategies and technology policies for poverty alleviation, including inter- and intra-sectoral relations, and food security	x	x	x	x
- Particular areas identified for policy analysis				
— irrigation policy	x	x	x	x
— fisheries	x	x		
— food programmes	x	x	x	x
— common property	x	x		x
— labour markets	x	x	x	x
— equity concerns	x	x	x	x
— trade and macro-economic policies	x	x	x	x
- Assessment of underlying causes of ongoing environmental degradation processes and identification of policy options				
— deforestation causes and processes	x	x	x	
— reforestation incentives	x	x	x	x
— chemical pollution	x	x	x	x
— soil erosion	x	x	x	x
- Land and water use management policies (e.g. water-sheds, coastal areas, rangelands, problem soils)	x	x	x	x
4. Research on research				
- Methods for ex-ante analysis of expected impact and for priority setting at the national and international level	x	x	x	x
- Ex-post impact assessment studies including development of methods	x	x	x	x

	ASIA	SSA	LA/C	WANA
IX. INSTITUTION BUILDING AND RESEARCH RELATED ACTIVITIES				
1. Training				
- Training of national staff on:				
— advanced research techniques	x	x	x	x
— field experimentation for junior professionals	x	x	x	
— system-based on-farm research	x	x	x	x
— research management and priority setting	x	x	x	x
2. Conferences and seminars				
- Specialized and network-orientated events	x	x	x	x
3. Documentation and dissemination of information				
- Specialized services	x	x	x	x
4. Research on institutional systems; e.g.				
- NARDS	x	x	x	x
- Irrigation systems	x	x	x	x
- Forestry systems	x	x	x	
- Fishery systems	x	x	x	x
5. Strengthening national research systems				
- Organization and management of research institutions	x	x	x	x
- Linkages among research, development, policy makers, and public opinion	x	x	x	x
- Research programme strategies	x	x	x	x
- Building capacity for policy analysis	x	x	x	x
6. Networks				
- Assist the establishment and administration of collaborative research and information networks	x	x	x	x

CHAPTER 5 - THE EVOLUTION OF THE CGIAR

5.1. Introduction

The CGIAR is only one actor in the global agricultural research system and commands only a fraction of its resources. The System has to be very selective in choosing among the many demands for agricultural research those it will help to meet. The CGIAR has played primarily a gap-filling and bridging role in agricultural research. Centres fill gaps in research that cannot be filled by national systems and provide a bridge to advanced institutions active in basic research. The CGIAR as a publicly funded international entity tries to identify themes and opportunities where national programmes have little incentive to become involved, either because of economies of scale or because spillover effects are so large they cannot be captured by them. The principal role of the CGIAR is to strengthen the work of national programmes by undertaking activities that are complementary not competitive.

Research is by its nature a long-term activity and its horizon expands further into the future as it moves from applied to strategic and basic research. This characteristic, coupled with the time required to establish or significantly change a research enterprise requires TAC to think about the decades ahead. The planning horizons of Centres have clearly changed; some are planning for 2010, some for 2025 and one even thinking about 2050. The CGIAR as an entity also ought to have long as well as medium and shorter term planning horizons. Investment in research today will have a payoff at the farmer level only 20 years from now.

The context for long-range planning has to be the food needs and poverty status of developing countries in 2025, within the constraints of increasing pressures on natural resources. These will be influenced by the major trends affecting food demand outlined in section 2.1. - population growth, income growth and urbanization. The magnitudes can be recalled as follows: The UN medium population projection for developing countries for 2025 is 7.0 billion people compared with 3.6 billion in 1985, and 57% will live in urban areas compared with about 31% now. The implications of these numbers are substantial. Assuming that the rate of land area expansion which prevailed over the last two decades continues (a very optimistic assumption), global yields of major marketed food and feed crops will need to more than double. In addition, the agricultural sector has a crucial role to play in the generation of income and employment.

It is against this backdrop that the future of the CGIAR is to be considered. Many more variables also need to be considered, including potential advances in basic biology which could increase biomass production; changing capacities of research enterprises - public and private - in developing, developed and centrally-planned countries; changes in institutions and policy regimes; and possible deterioration or improvement in the global resource base. The complexity of the task is enormous, but highlights the need for thinking about what role an international research operation should play in that context.

The CGIAR has always been a dynamic and expanding entity. From its inception in 1971 to 1980 it added nine additional entities/

institutes to its original four. It has since substantially expanded its intended subject matter coverage by: (1) encouraging a farming systems approach to research; (2) explicitly including in its priority criteria the potential for technical change to generate income and employment; (3) recognizing that increased food production was a necessary but not sufficient condition for reducing poverty and malnutrition; (4) including long-term sustainability of production systems to provide increased food supplies as an explicit part of its goal statement; (5) identifying resource conservation and management as an explicit goal of equal importance with productivity improvement; and (6) replacing an implicit goal of contributing to national food self-sufficiency with an explicit reference to achieving food self-reliance in the developing world. Each of the changes implied expanded and adjusted mandates for the existing 13 centres. In evaluating a possible expansion of the CGIAR it is necessary to carefully consider the optimal structure of the CGIAR.

This Chapter gives an overview of the evolution of the CGIAR. In Section 5.2. the rationale for the current structure is discussed while Section 5.3. presents a historical evolution of CGIAR priorities. Finally, Sections 5.4. and 5.5. provide an assessment of the key strengths and weaknesses of the CGIAR's present organizational structure.

5.2. Rationale of the Current Structure

The first two centres established by Ford-Rockefeller Foundation partnership were commodity centres (IRRI and CIMMYT) which focused on the three most important cereals - rice, wheat and maize. The approach was to use plant breeding to improve productivity by changing characteristics which would have wide adaptability. Adjusting the stature of wheat and rice produced high yielding varieties (HYV) which were potentially adaptable globally as long as sufficient water was available. Thus the notion of "global commodity centres" was the first approach.

The next two centres which predated the establishment of the CGIAR were very different in mandate. They were ecological zone, farming systems centres (CIAT, humid tropics of Latin America; and IITA, low altitude humid tropics of Africa). In their initial inception a full spectrum of activities, including livestock and presumably perennial crops, were covered. These farming system mandates obviously included the commodities of the so-called global centres.

Additions to the CGIAR in the 1970s and early 1980s continued to be a mix of so-called global (commodity) centres (CIP, ILRAD), global subject matter centres (IBPGR, IFPRI, ISNAR), regional/ecological centres (ICRISAT, ICARDA, ILCA), and a regional/commodity centre (WARDA). ILRAD as it has evolved more closely fits this latter category. As the CGIAR evolved, some of the regional centres assumed "global commodity" responsibilities in addition to ecological/regional mandates: IITA - cowpea, sweet potato and others; ICRISAT - millet, sorghum, groundnut; CIAT - beans and cassava; ICARDA - barley. Further, as the regional centres evolved they reduced the focus on "the systems" and focused on regional and/or global commodity programmes, e.g. CIAT, IITA, ILCA. Only recently have some partially returned to a resource base focus, e.g. IITA, ILCA and ICRISAT. Few have remained basically regional/ecology centres, perhaps only ICARDA qualifies.

Throughout the evolution all centres have had the strengthening of national programmes as important components of their mandates (including major investments in training and information retrieval, consolidation and dissemination). One result has been that the CGIAR System, when viewed from the country level, as well as from the donor perspective, was represented by a maze of overlapping research entities attempting to interact with national programmes. This problem became more acute in sub-Saharan Africa as was documented by the CGIAR Task Force (CGIAR Secretariat, 1989).

5.3. The Historical Evolution of CGIAR Priorities

5.3.1. The Early Focus on Food

The CGIAR was established in 1971, and in its early years was preoccupied with the expansion of the System. The early successes of IRRI and CIMMYT provided a momentum which the Group capitalized on. Its Technical Advisory Committee drew up the first priority statement for the Group in 1973 which suggested several new centres. The 1973 TAC Chairman's Position Paper on Agricultural Research Priorities (TAC Secretariat, 1973) reaffirmed poor peoples' food as the focus of the System and placed highest priority on cereals, the mainstay of their diets. Priority was also placed on improving the quality of diets through research on food legumes and ruminant livestock. Finally, starchy foods, including roots and tubers, were also recognized as a high priority, for their role as the basic staples of much of equatorial Africa and for their massive potential in terms of energy per hectare. At a secondary level the report selected oilseeds, tropical vegetables and fruits from a large group of other agricultural crops and expressed a need for careful appraisal of their economic and social importance and their market and research potential before further priorities were identified. TAC members expressed the view that forestry was perhaps of greater relevance in the context of environmental conservation than for timber production and processing. They also perceived that the need for factor-oriented research was best met through the commodity approach. The report carried reservations on the adequacy of this "spin-off" and cautioned the Group that it might eventually need to venture outside the commodity model.

The 1973 paper was a licence for expansion. It sanctioned ILCA's and ILRAD's beginnings, and the consolidation of CIP. It named the component crops of ICARDA as priorities, as well as additional programmes for ICRISAT, and it contained the germ of ideas for both IFPRI and ISNAR. The discussion of forestry and factor-oriented research anticipated the current concern about agricultural sustainability.

The success of the green revolution in wheat and rice in Asia, which owed so much to the work of CIMMYT and IRRI, helped ease immediate food concerns. It had two influences on the System's priorities. First, it demonstrated the value of international research on staple foods of poor people as a means of alleviating malnutrition. Second, it highlighted the importance of income generation in the process of alleviation of poverty and malnutrition. Both led to consideration of a further broadening of the commodity base of the CGIAR in an attempt to replicate the experience with wheat and rice.

5.3.2. Broadening the Commodity Base

Further priority papers in 1976, 1979 and 1985 recorded the progress in incorporating many of the TAC initiatives first listed in the 1973 paper (TAC Secretariat, 1976 and 1979 and TAC/CGIAR, 1987). They also made some adjustments in the priorities listed in 1973 and noted issues arising from the evolution and increasing complexity of the Group. The 1976 paper made first mention of the importance of increased cash incomes as a means of command over food, and the acknowledgement of increased food production as a necessary but not sufficient condition to feed the world's poor. The paper placed greater priority on the intensification of cropping, the development of improved farming systems and the need for better postharvest technology. It raised the question whether investment in cereals research had reached a ceiling in the CGIAR System. It emphasized the point, made in 1973, that the large calorie yields per unit area realized from tubers and roots might mean a greater role for them as population grew. It reinforced the case for greater investment in agricultural research in these crops, including starchy banana.

The 1979 paper confirmed a reduction from 50% to 38% in the proportion of CGIAR resources allocated to cereals between 1974 and 1980. It also noted a tripling of funding for livestock research since 1974. A feature of the paper was the ranking of research areas in which the CGIAR System might take new initiatives. Several of these had repeatedly featured in TAC discussions and papers in previous years:

- Tropical Vegetables Research
- Water Management Research
- Plant Diseases
- Insect Physiology and Ecology
- Food Policy Research
- Aquaculture.

Equally important, it listed areas in which action was not recommended at that time - oilseeds, plantain, agroforestry, water buffalo, cotton, fertilizers, tropical soils, postharvest technology, farm mechanization, other animal diseases. While giving soils, fertilizers and agroforestry a relatively low ranking, the paper acknowledged a need for more factor-oriented research to exploit the gains from improved germplasm, and also for more effort in food policy research - a recurring theme since 1973.

The role of farming systems research approaches pioneered by the IARCs helped capitalize on the potentials offered by the new germplasm in farmers' fields through improved rice and wheat based cropping systems. It led to a major effort to introduce a systems-based research process to national agricultural research services.

5.3.3. Institutional Considerations

Institutionally, the 1979 paper highlighted the need for collaborative research networks and for collaboration between Centres when mandates overlap, particularly where two or more were operating in the same country. It also placed emphasis on two major points. First, the need to build up national research capacity and expand country participation in global or regional research programmes. Second, the

need for international Centres to build up their awareness of national and regional problems in their respective mandate areas, including environmental and socio-economic and policy constraints which may limit the impact of research. Finally the 1979 report acknowledged the relevance of the project cycle in research; the fact that programmes should wind down as well as build up, and intimated that so far there was very little sign of winding down in any Centre's programmes.

5.3.4. Rationalizing Commodity and Regional Balances

The 1985 priority paper urged reduced relative allocations to wheat and rice. It suggested an increased relative allocation to maize, sorghum and millet on the grounds that these had been underresearched in the past, were increasingly widely grown, and had a dual role with the stem and leaves useful as animal feed. In this document, TAC suggested increased allocations to the starchy tubers, encouraged more work on sweet potato, and proposed support by appropriate CGIAR Centres for a new international networking organization, INIBAP, working on starchy banana.

The 1985 paper gave priority to extra work on crops producing edible oils and, in this context, encouraged increases in research on soybean and groundnut and offered coconut as a possible new venture for the System. It urged some extra allocation to ruminant livestock to be focused on the improvement of livestock nutrition, which the paper identified as the key research area. Finally it recommended that the work on faba bean and lentil be run down, on the grounds of their restricted geographical importance. In addition to coconut the paper urged the consideration of new ventures in tropical vegetables and aquaculture.

The paper also noted the shift of emphasis from food problems in Asia to food problems in Africa. It posed the question of how far the Centres could and should substitute for national programmes. Efforts to link with developed country institutions and pursue the benefits of biotechnology for the third world are currently drawing the Centres into more upstream research, away from location specific applied and adaptive research at the heart of national programmes.

The phase of early expansion worked itself out in the late 1970s. ICARDA was established in 1977; IFPRI, working on food policy research, joined the System in 1978; and finally ISNAR, helping developing countries to organize their agricultural research systems, was set up in 1980. These departures from agricultural research per se reflected an increasing recognition in the Group of two wider dimensions: first, the place of the CGIAR in a global research system, particularly its strong dependence on national programmes to reach poorer farmers; and second, the importance of an effective policy process for identifying and mobilizing technological innovations relevant to farmers and to national needs.

5.3.5. Concerns for Income, Employment and the Conservation of Resources

Since the last CGIAR priorities paper was reported in 1985, several factors have been recognized that are important enough to modify priorities. The first of these is the explicit inclusion, as a legitimate criterion for priority setting, of the potential of technical

change for income and employment generation. A second factor that will change the balance of resource allocation in the CGIAR, is the explicit, expanded emphasis on the long-term sustainability of agricultural production. This is manifested in the inclusion of improved resource conservation as an explicit CGIAR mandated objective and in a proposal to double resource management research. A third and related factor is the recognition that less progress has been made in the fragile and difficult environments, particularly the rainfed drier areas. The corollary of this is that the CGIAR must remain concerned with maintaining and enhancing productivity in the more favoured areas, which will have to provide the food for rapidly growing urban populations. The fourth factor is an implicit recognition of the contribution of equity, including gender equity, towards productivity and sustainability and conservation of natural resources.

Of equal importance is the need to shift towards more strategic research and also to exploit the existing technological developments arising from research in the biological sciences. The benefits of this "modern biotechnology" need to be secured for research in the developing countries. Added push for both these trends comes with the increasing capabilities of the research systems in some developing countries. Finally there is the explicit adoption of farming systems perspective for formulating and implementing research programmes.

5.3.6. Future Implications

All of these new and recognized dimensions require a fundamental reappraisal of CGIAR future priorities and demand a CGIAR perspective sensitive to its place in the global system, rather than a view locked into the narrow, specialized focus of the individual Centres. Several contemporary issues need to be addressed at the level of the Group:

- the principles and mechanisms for sharing international responsibilities between CGIAR Centres and mature national programmes
- the need to reconcile global, regional and national priorities through the operating processes of the System and the Centres
- the coordination of multilateral and bilateral funding within a global research strategy
- the need to consolidate regional agricultural research and rationalize the use of scarce funds.

Over the ensuing years, these wider dimensions are likely to play an increasing role in the thinking of the Group and in the allocation of its resources.

5.4. Major Strengths and Shortcomings of the CGIAR's Present Organizational Structure

5.4.1. Strengths

In considering a possible expansion of the CGIAR, it is appropriate to make a comprehensive assessment of its current structure.

There are certain structural features of the CGIAR which have contributed to its past successes. It would be desirable to preserve or put premium on these when considering alternative organizational arrangements. Some of the most important of these are listed below:

- Apolitical and international character. The System should maintain its apolitical, international character. This means representation of national, institutional or other political entities should be strictly avoided in its governance and staffing. It also means that the legal charters of the institutions supported by the CGIAR should protect them from political interference and help maintain their international character.

- Decentralized management. The CGIAR derives much of its success from its commitment to decentralize management through independent, autonomous institutions. Centralized management could move decisions too far away from places close to the problems and limit operational flexibility in day-to-day supervision of decentralized activities. A corollary of managerial autonomy is a strong system of external accountability, which should also be preserved.

- The concept of critical mass. The success of the CGIAR has been actuated largely through bringing together at each centre a critical mass of internationally recruited, multi-disciplinary scientists, with all the necessary supporting facilities.

- Hands-on research capability. Research is the main business of the centres and the System. The centres' success in research-related activities such as training and information dissemination are perceived to be a direct result of their hands-on involvement with research. Also, the centres play a more credible strengthening role vis-a-vis the national programmes when they have hands-on research experience themselves.

- Closeness to clients/partners. Many of the present centres have found it necessary to decentralize their operations geographically in order to be close to their clients. Some carry out much of their training in decentralized locations. To the extent frequent contact with the centres' clients/ collaborators is necessary, it is more efficient to do this from locations close to them.

- Stable and flexible funding. In order to implement their strategies (which often involve long-term research) effectively, the centres need stable funding. The funding also needs to be provided sufficient flexibility for the centres to engage in activities directly relevant to their main mission. Heavy reliance on special project or other restricted funding often constrains a centre's capacity to pursue activities in the direction outlined in its strategy.

- Sound experience in research with a commodity focus. The CGIAR has a proven track record in solving problems through research

centres organized along commodity lines. Although the number and combination of commodities worked on by each crop centre may be debatable, if the centres are to "stick to their knitting" (or continue doing what they do best), a clear commodity focus may need to be maintained in the future, at least in some of the work.

5.4.2. Shortcomings

Some of the organizational features of the CGIAR listed in Section 5.4.1. represent both its strengths and weaknesses. For example, the part of the centres' funding that is stable and flexible is a distinct strength. But, the part that is inflexible and unstable is a weakness. Certain other features of the CGIAR's organization also present some weaknesses:

- Overlapping commodity mandates. These have been a frequent cause of conflict and misunderstanding within the System. When two or more centres are given responsibility to work on the same commodity, conflicts are found to arise even when the responsibilities have been clarified on the basis of either geography or type of research (i.e., strategic, applied, adaptive) or both. Having two or more centres work on the same commodity demands complex inter-centre agreements and coordination mechanisms which can lead to inefficiency and become difficult to implement.

- Overlapping resource management mandates. Centres with global commodity mandates carry out some resource management tasks connected with that commodity on a global basis. Centres with regional mandates are concerned with resource management concerns on an agroecological basis. Since both types of centre are essentially working on the same resources, some confusion tends to exist on the limits of their respective responsibilities and, of course, major resource issues could fall between the chairs.

- Lack of clear global responsibility for strategic research on resource management concerns. The System is going through the current expansion phase primarily because resource management concerns have been given a back seat position compared with commodity and regional research. This is particularly true for fundamental, strategic research questions on resource management that have inter-country and inter-continental relevance (e.g., soil degradation, crop-physical environment interface, Vertisols, etc).

- Uncoordinated decentralization. Each centre has decentralized its operations based on its own needs. Research on many of the new activities being considered (such as forestry, fisheries, agroforestry, water management, etc.) will also have to be carried out in a decentralized fashion because of the location-specificity of the problems that need study. While independent and separate efforts by each centre could best serve its own purposes, this may lead to increasing inefficiencies for the System as a whole.

- Lack of intra-system coordination of the centres' capacity building efforts. ISNAR plays a role in strengthening entire national agricultural research systems, particularly in the area of their organization and management. Each of the other centres includes the strengthening of national programmes as a part of its mission. Although the efforts of the centres are all directed towards different aspects of a national system, these efforts are disjointed. No mechanism exists to ensure coherence and complementarity of the total CGIAR effort vis-a-vis a given national system. The same is true for the centres strengthening efforts directed at regional institutions.

- Overburdening of weak and/or smaller national systems by attention from many IARC's. Related to the previous point, there is a lack of coordination, and sometimes even competition between centres in their dealings with NARS. It is inefficient for weak and/or smaller NARS to interact simultaneously with many IARCs.

- Lack of coordination of the centres' capacity building efforts with technical assistance programmes of donors. Donor technical assistance programmes geared towards improving the capacity of developing country, national, and regional research systems are not well coordinated with the centres' own efforts in the same area. New mechanisms may need to be created to ensure the complementarity of these efforts.

- Weak accountability to clients/partners. Present accountability mechanisms within the System are geared towards the centres' accountability to the donors. There are no formal and direct means through which the centres' clients/partners can voice their opinions strongly. As there are practically no alternative suppliers of the services the CGIAR centres provide to national institutions, the "market mechanism" does not serve as an accountability reinforcing device.

- Need for rationalization of the System's activities. Several centres carry out complementary work in the same or related areas. Restructuring the centres' mandates can lead to gains in efficiency, particularly if this reduces duplication. Complementarities in research on root and tuber crops, for example, may be better exploited if one centre had a critical mass of people working on all such crops. The same could be said for research on other commodities and for work on policy and management questions.

CHAPTER 6 - PROCESS OF ANALYSES AND CRITERIA USED

6.1. Introduction

As discussed in Chapter 1, TAC was requested in May 1988 to examine a possible expansion of the CGIAR to incorporate ten of the so-called "non-associated centres" 1/. This Chapter describes the process and criteria used in the assessment of the non-associated centres. In approaching this task, TAC decided that it would be necessary to reconsider: (i) the CGIAR in its global context; (ii) CGIAR research priorities and possible new areas of subject matter coverage; and (iii) goals, relevance of activities for CGIAR support, modalities and overall organizational structure in an expanded CGIAR.

The Chairman of TAC subsequently proposed a substantive outline of the process TAC would follow, a proposed set of criteria for assessment of the candidate institutions and a timetable. The approach proposed in this outline was endorsed by the Group at ICW 1988. At the Mid-Term Meeting in Canberra (May 1989), the CGIAR agreed in general terms to broaden its mandate with a declaration of intent "... to continue to give emphasis to support for research on technologies and systems of enhanced food production that can be sustained by farmers over time through the efficient utilization of their renewable natural resource base, and to expand this emphasis to include research on the optimal use of tropical and sub-tropical forest lands giving particular stress to the interaction of agriculture and forestry...". TAC's deliberations on forestry have proceeded in a parallel fashion with the consideration of the "non-associated centres" until TAC's membership was augmented by forestry expertise at TAC 51 in March 1990, when the two processes were integrated.

6.2. Process Followed

6.2.1. Future Demand for International Agricultural, Fisheries and Forestry Research

TAC first examined the global context in which the CGIAR would be likely to operate during the next three decades. Particular attention was given to future demand for food and expected trends in world agriculture, fisheries and forestry, which indicate that malnutrition, poverty, and the processes of resource degradation would continue to be widespread problems throughout most of the developing world. The extent and implications of these trends were discussed with Centre Directors and Board Chairs at TAC 47 (October 1988) and 48 (March 1989).

TAC Members and the TAC and CGIAR Secretariats collaborated to prepare regional essays to analyze relevant evolving trends in each of the four developing country regions, namely Asia and the Pacific,

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1/ The institutions to be considered for membership were, in alphabetical order, AVRDC, IBSRAM, ICIPE, ICLARM, ICRAF, IFDC, IIMI, INIBAP, ITC and IUFRO-SPDC.

sub-Saharan Africa, Latin America and the Caribbean, and West Asia/North Africa. For each of these regions, an analysis was made of the challenges to agricultural development and resource management, and the resulting implications for research. In each essay, forestry issues were explicitly addressed. These essays were discussed at TAC 49 (June 1989).

The analyses of both the global and regional perspectives led to the formulation of demands for international research. An attempt was made by TAC to prioritize these demands by research category and by region. This led to the preparation of the inventory of identified needs for international agricultural, fisheries and forestry research presented in Table 4.3. (pp. 54-62).

6.2.2. Interim Report and Consultations with Members and Partners of the CGIAR

TAC's analysis of the future demand for international research on agriculture, fisheries and forestry in developing countries, the scope for CGIAR support for research and related activities, a discussion of the rationale for the need for a reassessment of CGIAR goals, priorities and strategies and the outcome of TAC's preliminary inventory of current efforts were summarized in a paper "A Possible Expansion of the CGIAR: Part I - Interim Report". This paper was presented to members of the CGIAR at ICW 1989, who endorsed the approach taken by TAC. The Interim Report was circulated widely for further written comments to all members of the CGIAR, including fixed-term representatives, donors, and Co-Sponsors, as well as to CGIAR and candidate non-associated centres with a covering letter soliciting comments. The responses received were summarized, then discussed at TAC 52 (June 1990) when decisions were taken about how the document should be revised.

A concerted effort was also made to discuss the Interim Report with as many representatives of national research programmes in developing countries as possible. In order to keep these consultations cost effective, they were done within the framework of regional meetings already scheduled by other organizations. At the request of TAC, the Interim Report was put on the agenda of these meetings and the comments received were taken into account when finalizing this report. These regional meetings are listed in Annex I.

6.2.3. Desk Analyses and TAC Fact-Finding Missions

In the meantime, the TAC Secretariat prepared a desk study on each of the candidate non-associated centres using available published information. These studies summarized, for each of the non-associated centres under consideration, the mandate, governance and structure, funding and available resources; the strategic plan, and the research, training and information programmes; and provided a list of donors and a list of available documentation. A financial analysis was prepared by the CGIAR Secretariat. In addition, several subject matter background papers were prepared by the TAC Secretariat and consultants. These addressed both CGIAR and non-CGIAR activities in broad areas such as resource management, crop protection and livestock diseases.

The desk studies and background papers provided information to Panels that undertook fact-finding missions in April/May 1989 to each of

the candidate centres except AVRDC. These TAC Panels were each composed of at least two TAC Members, one outside expert, and a member of both the TAC and CGIAR Secretariats. They were chaired by a TAC Member. Each Panel prepared a report that provided further detailed information on the programmes, strategy, results and impact obtained, resources available, and management of the respective candidate non-associated centre. The reports also contained an initial briefing for TAC on specific issues and concerns. These reports were discussed at TAC 49 (June 1989) and TAC 50 (October 1989).

6.2.4. Subject-Matter Analyses and Further Consultations with Outside Experts

As the next step, TAC decided to undertake an analysis of research needs and ongoing efforts for each subject matter area represented by the non-associated centres, with a particular focus on the role of the CGIAR in these areas.

The TAC Secretariat, assisted by the CGIAR Secretariat in the area of agroforestry, undertook a further background study on each of these subject-matter areas. The following issues were considered: (1) the need for future CGIAR activities in each subject-matter area; (2) the extent to which this need was already met by existing CGIAR Centres; (3) how the activities of the candidate non-associated centres related to those of CGIAR Centres and other institutions; and (4) to what extent the activities, modes of operation and institutional nature of the non-associated centres conformed to those considered acceptable to the CGIAR. Each of these subject-matter areas was reviewed in January-May 1990 by a panel comprised of at least two TAC Members, two or more outside experts or resource persons, and appropriate staff of both Secretariats. The panels were asked to review the subject matter and the centre(s) embedded in it. A total of eight reviews were planned in the following areas: banana and plantain (INIBAP), vegetables (AVRDC), fisheries (ICLARM), research related to livestock diseases in sub-Saharan Africa (ITC, ICIPE), crop protection (ICIPE), natural resource conservation and management (IBSRAM, ICRAF, IFDC, IIMI), tropical forestry (ICRAF, IUFRO/SPDC), and the interface between national and international agricultural research.

The Panel on the Interface between NARS and IARCs met in Washington DC in January 1990. Six other Panels met in Rome in early March 1990 prior to TAC 51 to review the desk studies, background papers and fact finding-mission reports, to appraise whether additional information was needed and to make a preliminary assessment of the non-associated centres. The guidelines for and composition of these Panels are presented in Annexes II and III. In making their decisions, the Panels utilized the decision tree described in Annex II and explored various institutional options in those cases where no clearcut (yes/no) decisions about the inclusion of a non-associated centre could be made.

The findings of the seven Panels were discussed at TAC 51 (March 1990), and an initial assessment was made based on the Secretariat desk studies and the panel reports. TAC reached tentative conclusions on each centre but deferred final decisions until vegetables and AVRDC had been reviewed and the broader CGIAR System-wide issues had been considered.

A special comment on forestry and agroforestry is necessary. Considerations in forestry had proceeded through interactions of the CGIAR Secretariat and TAC's Forestry Panel with a broad cross-section of forestry and agroforestry related experts on a sequence of papers, one of which dealt specifically with agroforestry. A wide range of institutional options was developed separately for forestry and agroforestry. At the Panel meetings in Rome in March 1990 the issue of the appropriate role and institutional mechanism for agroforestry was assigned to both the Panel on Natural Resources and on Forestry. Each was asked to review agroforestry in the context of broad resource management issues and in the context of forestry. Both Panels concluded that it is best to look at this question in the context of a continuum of land use from agricultural cropping in which trees play a contributing role through to natural forests and plantation forestry in which trees dominate. Given the merging of forestry and agriculture that is resulting from increasing population pressure on forest land, sustainable production of mono, as well as multiple crop/tree systems, is not easily partitioned. Each Panel operating independently came forward with very similar recommendations for integration of forestry and agroforestry research both at the regional and global levels.

TAC in its deliberations endorsed the general form of the recommendations on forestry and agroforestry. It decided to move forward with an interim set of recommendations on both substance and form for discussion at The Hague in May 1990. The response from the CGIAR in May allowed TAC and the two Secretariats to move forward in preparing a comprehensive proposal for ICW 1990. TAC had deviated from its previous position of insisting that all subject matters be considered simultaneously because it was convinced that the proposed mode of operation for forestry and agroforestry would be consistent with any final rationalization of the CGIAR proposed by TAC.

At TAC 52, a new TAC Standing Panel for Resources Management, Forestry and Agroforestry was created. This Panel was formed to help carry out the charge given to TAC by the Chair of the CGIAR following the Mid-Term Meeting in the Hague. The charge was as follows: develop further the recommendations for a centralized institutional mechanism for the incorporation of forestry and agroforestry into the CGIAR System; conduct an informal dialogue with ICRAF to determine the implications of the proposal for ICRAF's current programme and structure; and collaborate closely with FAO, IUFRO/SPDC and interested donors in identifying parallel mechanisms for ensuring more systematic support for non-CGIAR financed forestry/agroforestry activities and for strengthening the capability of weaker national forestry institutions. The Standing Panel consulted with outside experts and with ICRAF staff in Washington in July and Rome in August before finalizing its report.

Special comments are also necessary in the case of coconuts. The 1985 TAC Review of Priorities and Strategies identified coconut as a priority commodity for international support. TAC subsequently commissioned a consultant to review coconut research needs and priorities. The consultant's reports were considered by TAC at its 46th, 50th and 52nd meetings. TAC decided at its 50th meeting in October 1989 to consider coconut research in parallel with the assessment of the non-associated centres, thus ensuring that one new initiative on this commodity would be appropriately woven into the fabric of a restructured CGIAR System.

The reports and recommendations of all eight Panels were discussed at TAC 52 (June 1990) when TAC reviewed its assessments of individual Centres in the context of the future structure of the CGIAR. TAC approached the issue of the future structure of the CGIAR by analyzing and discussing in detail the long-term vision of the System and the changes needed to achieve it. After TAC 52 this report was drafted then finally discussed and approved by TAC at a special meeting in August 1990.

6.2.5. Analysis of Future Activities and Modes of Operation

At TAC 51, after receiving the reports of the Panels, the Committee discussed options for future activities and modes of operation within the CGIAR System, based on a background paper. The issues raised were the special nature and characteristics of the CGIAR, the boundaries of system activities, the role of international centres in networks, the division of responsibilities among centres, alternative modes of operation and strategies for collaboration with national programmes. This working paper was designed to raise issues that are central to the role and function of the CGIAR. It was therefore provided to the Group for consideration at the 1990 Mid-Term Meeting in The Hague to obtain feedback which helped TAC to formulate its position on these issues.

Another key issue which TAC had to take into account in the assessment process is the mission and goals of the CGIAR. Out of TAC's discussion of the Interim Report, arose a consensus that there was a clear need to review the goals and operational objectives of the CGIAR. A mission statement was developed, along with revisions of the goals statement which incorporated agriculture, forestry and fisheries. The decision was also made to incorporate the concept of self-reliance. The revised CGIAR mission and goals statement is presented in Chapter 7.

6.3. Criteria for CGIAR Support

6.3.1. Guiding Principles

The most recent priority and strategies paper (TAC/CGIAR 1987) defined a number of general criteria for CGIAR support which are still valid. These include the requirements that activities should be regarded as research or be research-related, be relevant to the CGIAR mission and goals and have high potential for pay-off.

Of these criteria, the question of research and research-related activities draws a considerable amount of TAC's attention because it encompasses important issues such as the strengthening of national research systems and the boundaries of the CGIAR System vis-a-vis research, development and technical assistance. Since the programmes of a number of the non-associated centres appear to straddle these boundaries, TAC considered it essential to develop a clear policy on which types of activity are appropriate for centres in the CGIAR System.

Another question that is frequently raised is whether the commodity focus of those CGIAR centres involved in productivity research enables them to give sufficient attention to research on the "factors" of production, such as fertilizers, soils, water and pest control. In response to the CGIAR's decision to expand its support for research on

the management of natural resources, TAC has re-considered this question, both with respect to the scope of the activities that should be undertaken and to the ways in which it should be organized.

The next sections of this Chapter discuss these issues in some depth and elucidate the TAC policy. This is followed by a statement of the more specific criteria used by TAC in the assessment of the non-associated centres.

6.3.1.1. The Role of International Centres in Strengthening National Research Systems

International research institutions might be expected to make their main contributions to strengthening national research systems through scientific collaboration and by providing information and improved genetic material. International development agencies would be expected to contribute through training, technical assistance and capital grants. The issue often arises of the extent to which the CGIAR Centres should function in both capacities.

As far as training is concerned, the involvement of the Centres is unlikely to be controversial. Although the training offered by them could never become a substitute for formal training at universities, it can make an important contribution to the overall training needs of national research systems. Indeed, training is a natural function of the Centres and fits comfortably into the philosophy of the CGIAR.

Technical assistance and the administration of funding for strengthening national research capacities are not international in character, however, and are often associated with bilateral agreements that are inevitably influenced by the policies of a single donor. They are therefore more difficult to reconcile with the basic precepts of the CGIAR.

These considerations give rise to important issues relating to possible ways in which the CGIAR should contribute more directly to strengthening national research systems. Many of the important considerations are implicit in the two questions that follow.

- What are the advantages and disadvantages of the Centres being involved in technical assistance and the administration of development funds for strengthening national research capacities?

- What mechanisms, if any, should be adopted by an expanded CGIAR System for fulfilling such functions?

6.3.1.2. International Centres as Development Agencies

Direct involvement in development projects designed to strengthen national research systems has several advantages for the Centres. It provides a ready means of extending their working relationships to a greater number of developing countries. It helps them to validate their findings by providing feedback from a range of environmental and socio-economic conditions, and it gives them greater opportunities for impact. It also gives them access to bilateral funding that might not otherwise be available.

From the donor's point of view, implementation of the research component of a bilateral development project by an international Centre might present the easiest option. As well as being best placed to provide the technical input, Centres are often better placed than donor agencies to recruit personnel for technical assistance and to provide them with logistical support.

It might also be easier for the Centre to administer the funding. Some donors have mechanisms for administering small grants, either through their own technical assistance activities, or through their Embassies or High Commissions. Others apparently have not. Some find it particularly difficult to administer the small amounts of funding involved for each participating country in a networking activity. This is one of the reasons why they call on the Centres to do it for them.

There have undoubtedly been occasions when involvement of Centres in bilateral development projects has benefited both the Centre's research programme and the national systems involved, but there are also dangers in these relationships that tend to become greater as the Centre's involvement in them increases. Indeed, over-involvement in bilateral projects, whether with individual countries or in a networking mode, can have distorting effects on both the Centre and the national systems.

For example, staff appointed as international scientists may have their productivity eroded through heavy routine administration. Pressure from individual donors may distort the Centre's priorities. A Centre might seek participation in bilateral projects primarily to obtain the funding or to achieve impact. This could distort the priorities of the developing country. Centres can become over-committed, resulting in the recruitment of staff for technical assistance who have little more experience than the national scientists, and do not command their respect. In one or more of these ways, the credibility of the Centre might be undermined.

Although all Centre involvement in bilateral projects now comes under the scrutiny of TAC, it has been difficult for TAC to make adjustments to agreements that have already been entered into. Furthermore, from the donor's point of view, these grants are not fungible. To reject them would therefore mean depriving the developing countries of badly needed resources to strengthen their national research systems. Even classifying such activities as "desirable" and not "essential" has caused problems for both the donors and the Centres. There is a limit, therefore, to the extent to which TAC itself can prevent the distortion of priorities, unless it were to take a more hardnosed attitude, which might well be regarded as unnecessarily obstructive by all concerned.

6.3.1.3. The Need for a Development Function

The development function is necessary only for the weaker national systems, but is essential if the benefits of centre activities are to be fully exploited. The stronger national systems can take advantage of centre outputs without the need for development assistance. The dangers outlined above arise primarily when the centre acts not only as an international research institute, but also as a development agency.

The logical inference would be that centres should not move into activities that are primarily the role of development agencies. Such a policy would be acceptable, however, only if there were adequate alternative mechanisms for filling the gap. The fact that some of the centres fulfil this function suggests either that there are not, or that certain donors prefer not to use them.

As far as the CGIAR Centres are concerned, it has often been said that the problems could be avoided if the Centres showed greater restraint and the donors showed greater discipline. In reality, many members of the CGIAR abide by the unwritten rules and refrain from asking the Centres to act as implementing agencies for their bilateral projects, while others have employed development agencies outside the System.

An alternative would be for each Centre to fulfil the development role through a self-financing development unit, created specifically for this purpose within its overall structure, and actively seeking contracts from bilateral donors. Although such a proposal has not been explicitly discussed by the Group, past indications would suggest that it would not be widely supported because of the different character it would imply for the System.

6.3.1.4. Appropriate Centre Activities

In TAC's view, Centres supported by the CGIAR should continue to function primarily as research institutions. They should continue to cooperate fully with international development agencies and bilateral donors by providing scientific and technical inputs into development projects designed to strengthen national systems. In general, however, they should refrain from acting as implementing agencies for such projects.

TAC recognizes that exceptions to this general rule might sometimes be made in the best interests of fulfilling the Centre's mandate, but such exceptions should always be determined by the Centre's priorities, not by the donor, nor by the wishes of a specific developing country or group of countries. Thus, the criteria should be very different from those that would determine the nature of a development project designed to strengthen specific national programmes, which should clearly be determined by the countries concerned.

TAC also recognizes that the CGIAR cannot give adequate support to the weaker national programmes through Centres that provide only information, advice and training. For the weaker national systems, there is a complementary need for development projects to strengthen their research infrastructure and, sometimes, for technical assistance as well. In contrast to meeting the needs of a Centre's mandate, however, such projects must be carefully designed to meet the priorities of the countries concerned and they might also need to incorporate aspects of research lying outside the mandate of a single Centre.

TAC sees these requirements being more easily met by development agencies that can draw selectively on scientific collaboration from the whole range of available research institutions, rather than attempting to meet them through the activities of individual CGIAR Centres. TAC therefore sees a need to strengthen collaboration between the CGIAR

Centres and those development agencies that are well placed to act as implementing agencies for bilateral and multilateral projects. Only when there are clear advantages to the Centre's research programme should such activities be undertaken by the Centres themselves, and donors should show restraint in calling upon the Centres to act in this capacity.

Consideration of the role of the System as a whole in this context must also include the activities of ISNAR, which was created by the CGIAR as a separate entity specifically to help national systems to strengthen their own capabilities. TAC sees the role of ISNAR as being entirely complementary to that of the other centres.

6.3.1.5. The Scope of CGIAR Research on Natural Resources

The past focus of the CGIAR on increased food production and the alleviation of poverty has coincided with a conscious effort to address those same issues by many national governments and external aid agencies. As research by the CGIAR Centres has produced higher yielding varieties, complementary investments by many national governments in rural infrastructure, strengthened extension and input distribution services have forged an essential link between research and development.

The credibility of the CGIAR System and the willingness of the donor community to sustain and expand financial support over the years have been, in large part, a reflection of the success that has been achieved in developing these linkages. It has been possible to quantify the impact of research on increased yields, food security, family income, welfare and trade.

As the System contemplates a broader mandate by incorporating research on the management of natural resources, it will need to develop clearly defined criteria for evaluating the likely impact of such research on sustainable development. This topic requires a more comprehensive treatment than can be given in this paper. However, it is possible to identify some guiding principles for CGIAR research related to natural resources that could help to ensure that the System retains a high level of credibility and donor support.

First, it will be important for the System to become involved in the measurement of rates of resource degradation and improved understanding of the underlying causes. Some of the current global concern about environmental degradation is emotive and scientifically questionable.

Second, it needs to be acknowledged from the outset that there are areas of emerging global environmental concern that will inevitably have to be tackled by scientific agencies other than the CGIAR. An example is the greenhouse effect and global warming trend. Scientific measurement of atmospheric changes resulting from global warming requires resources on a scale that will far exceed the CGIAR resources or scientific capability.

Third, it would be preferable that CGIAR-supported research in the area of sustainable resource management be set within the framework of clearly identified, quantifiable and realistically achievable

short-term and longer-term development objectives. For example, a CGIAR-supported research initiative to protect the biological diversity of threatened ecosystems could relate to the objective of immediate conservation and enhancement of the naturally occurring germplasm of several commercially important agricultural crops, such as coffee, cocoa, palm oil, rubber, and avocado, the yield and value of which can be readily quantified. There could be an early pay-off from such research.

As an example of research with longer-term potential pay-off, a CGIAR research effort directed at increasing productivity of key multipurpose tree species could be linked to the development objective of reducing the impact of acute fuelwood scarcity. Given the time required to carry out improvement of naturally occurring fuelwood species and to achieve significant yield gains through tree breeding, it would take a decade or more for the results of such research to become apparent. However, the ultimate impact could affect a large proportion of the estimated 100 million or more people in the developing countries likely to be facing acute fuelwood shortage. Moreover, increasing the yield of fast growing tree species would simultaneously help to reduce pressure on natural forests which, if situated in upland catchment areas, could have a positive regulating effect on downstream supplies of irrigation water.

6.3.1.6. International Research on the Factors of Production

Research on the main factors of production is closely related to the conservation of natural resources, particularly in the context of soil degradation, maintenance of biodiversity and the prevention of environmental pollution. Expanded effort by the CGIAR System in this area implies greater emphasis on soils, water, fertilizers and crop protection.

However, in the context of problem-solving, none of these factors can be considered in isolation. Each is dependent, to a greater or lesser extent, on one or more of the others. Moreover, all have to be understood in relation to the prevailing agroecological and socio-economic environments.

TAC does not, therefore, favour concentration of effort on a single factor of production in a single institution. Rather, research on problems involving these factors of production should be done by multi-disciplinary teams, under the management and coordination of a single institution, concentrating on the problems of a clearly-defined agroecological region. TAC's views on appropriate institutional arrangements to accomplish this within the CGIAR System are elaborated in Section 8.6.

6.3.2. Specific Criteria

In addition to the guiding principles discussed above, TAC devised the following specific criteria for assessing the non-associated centres.

6.3.2.1. Relevance to Mission and Goals of the CGIAR

TAC assessed the relevance of the activities of non-associated centres and forestry to the expanded mission and goals of the CGIAR. In general, all candidate centres had activities which were considered to be relevant. The subject matter areas covered by the non-associated centres provide priority research opportunities and have potential for contributing to sustainable food, fish and forest production systems and sustainable resource use.

6.3.2.2. Nature of Activities

TAC believes that a necessary criterion for CGIAR support is that the candidate activities could be regarded as research in the sense of the creation of new knowledge, or that they should be directly related to research. Such activities would include those that enhance the effectiveness of research, such as collaboration with other research institutions, training in research methods and assisting in planning, organization and development of research systems.

TAC carefully considered the nature of activities undertaken by the non-associated centres (including forestry and agroforestry-related) and the extent to which they could be considered as strategic, applied or adaptive research, or aimed at extension or institution building (see Table 1, Annex II). TAC believes that a candidate centre should qualify for CGIAR support only if a substantial part of its research activities are strategic and applied in nature, and are of an international character.

6.3.2.3. Focus and Economies of Scale

In assessing expansion of the CGIAR, TAC believes that important considerations are economies of scale, the need for an interdisciplinary approach, the scope for strategic research and access to germplasm resources where relevant. An additional aspect is the extent to which a CGIAR involvement would be cost effective, particularly with respect to investments by other organizations involved in the area. Clearly the CGIAR cannot do everything. It must select those activities which it is clearly able to do better than other partners.

6.3.2.4. Complementarity of Efforts

The activities of candidate non-associated centres were given close scrutiny by TAC as to their complementarity with those of other research organizations in developed and developing countries, including CGIAR Centres, regional research organizations and national programmes. The scope for further cooperation and collaboration was also carefully considered.

6.3.2.5. Quality Prerequisites

While TAC was unable to complete a comprehensive quality review on all centres, it did utilize all available information, including recently completed external reviews of several centres, to form a

collective judgement on quality. Quality must be assessed on the basis of qualifications and international standing of professional staff, publication records, potential for impact, effectiveness of management and standards of work. TAC continues to consider high quality of work an essential criterion for CGIAR support.

6.3.2.6. Mandate and Governance

TAC reviewed the mandate, organizational structure and governance of candidate non-associated centres. These should conform to those considered acceptable for CGIAR Centres. Mandates were analyzed in relation to their relevance to the CGIAR goal with respect to discipline, policy issues, resource management, activity, commodity, geographical region, agroecological zone and institution building. Governing bodies should be international as well as independent of political interests. The pattern of internal organizational structure, funding mechanisms and management have to be such that the candidate centre would be able to command the confidence of CGIAR donors.

CHAPTER 7 - CGIAR MISSION AND GOALS: IMPLICATIONS FOR PRIORITY SETTING

7.1. Introduction

In considering the future of the CGIAR, it is necessary to carefully assess the goals of the System and formulate explicit priorities for the next decade which take into account the changes that have occurred since the last Review of CGIAR Priorities and Strategies (TAC/CGIAR, 1987). This Chapter provides a discussion of the mission and goals of the CGIAR and of the implications of the broadening scope of CGIAR priorities. It also gives an overview of other considerations important in the reassessment of CGIAR priorities.

7.2. Redefining CGIAR Goals

The goal statement for the System, adopted in 1986, reads as follows:

> "Through international agricultural research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of low income people are improved."

TAC further elaborated on the goal as follows:

> "The CGIAR supports a System devoted to agricultural research and related activities for the benefit of developing countries. Its main effort has been directed towards the elimination of food deficits, but the scope of its activities has been gradually broadened. While not a development agency, it has become increasingly concerned with problems of alleviating hunger and poverty, recognizing that both relate not only to total production, but also to the distribution of income. More recently, TAC, the Impact Study and the Bellagio group have all drawn attention to the importance of sustainability of production systems and to the conservation of natural resources.
>
> The System recognizes that its purpose cannot be achieved in isolation and that it is only one participant in a vast, interrelated set of activities. Through increasing collaboration and partnership, it must constantly contribute to strengthening national systems. In order to maintain its vitality, it must also collaborate with appropriate advanced institutions throughout the world. To be effective it must be selective, avoid duplication and concentrate its efforts." (TAC/CGIAR, 1987 pp. 219-220)

The 1986 goal statement refers to "increasing sustainable food production ..." (emphasis added). It is suggested that this goal of increasing food production should be modified to incorporate the concept of achieving food self-reliance in the developing world (food self-reliance being defined as the capacity of a nation to provide a sufficient stable food supply to all of its inhabitants, either from

domestic production or from production of exportable goods to enable commercial imports to cover the domestic deficit). It should be clearly understood that food self-reliance does not necessarily imply food self-sufficiency. Rather it implies producing those things that a country is able to do best and, where necessary, trading them for required food. A goal of self-reliance has several implications. Although the range of commodities that are potentially in a production system is likely to be large, this does not, and should not, commit the CGIAR to working on all commodities; but it does commit the CGIAR to taking account of diverse production systems and their capacities to produce income and employment as well as marketable commodities. The direct implication is that the CGIAR should not rule out, by prior assumption, any commodity that contributes to food self-reliance either directly or indirectly.

7.3. Implications of Expanded CGIAR Goals

There are several direct implications that would follow from this expanded priority statement.

First, given population growth and urbanization, the CGIAR should retain high priority for basic crops grown in more favoured areas (e.g. irrigated) because it is the marketable surplus grown in these areas that will help feed urban, predominantly poor populations.

Second, parallel with this goal, there should be continued attention given to indigenous, subsistence crops which feed rural populations in less favoured areas. In stating this priority it must be clearly understood that progress in these areas will be more difficult, slower and quantitatively less in contributing to the national food supply and that these areas will not provide significant surpluses for non-farm populations. The balance between favoured and less favoured areas is critical and will be different by country, region, commodity and farming system. In order to expand from the necessary focus on continued production growth, towards a consideration of such growth together with access to food by the poor, increased attention should be given to complementary policies and programmes to alleviate hunger and poverty. This may be of particular relevance to less favoured areas. Nevertheless, yield gains accomplished to date in more favoured areas must not be abandoned. These yields need to be sustained and enhanced if long range food self-reliance in 2025 is to be achieved.

The third implication of the goal of assisting countries to achieve sustainable food self-reliance is that increased attention must be paid to the management of natural resources. This concern with resource conservation and management is absolutely critical to a sustainable production system. The critical question for the CGIAR is the portion of this type of research for which an international system has a comparative advantage. In the extreme it can be stated that each country, each region, each district and even each farm has a unique resource base. For some it follows from this that research on natural resource issues is so location specific that it can only be done by national programmes. But is this really true?

Clearly some major resource issues transcend national boundaries. For example, deforestation results in flooding and subsequent water shortages, increases erosion and siltation of downstream reservoirs, increases environmental pollution and ultimately diminishes capacity to

produce agricultural commodities in favoured and less favoured areas alike. River basins are often shared across national boundaries as several major basins in Asia show. Further examples, such as international migration of pests and diseases, wind erosion and pollution are prevalent. An international research organization could contribute by: (1) clearly defining the magnitude and potential future consequences of the process; (2) by contributing methodology for characterizing, analyzing and evaluating interventions in major ecological zones; (3) collecting, evaluating and disseminating available information from the global research community that is relevant to national policy choices; (4) doing actual research on a selective basis to both develop methodology and basic information and to provide examples of how to do it; (5) providing training; and (6) exploring appropriate institutional and management approaches.

The fourth implication is that a sustainable agricultural system involves both issues of productivity - expanding yield potential by breeding, soil amelioration and engineering, and improving management to reduce the yield gap - and long-term resource management. The intellectual challenge of converting a concept of, and commitment to "sustainability" into operational research programmes and for setting priorities within research programme is enormous. The CGIAR has a critical leadership role to play in this area.

The fifth implication is that specific attention should be given by the CGIAR to forestry. This recognizes the essential role that forests, and on-farm trees play in contributing to agricultural productivity, sustainable land use, energy needs, income generation and trade. They also provide a variety of services that have usually been poorly appreciated and valued. Further, there currently exists no satisfactory mechanism for supporting emerging forestry research priorities.

The sixth implication is that more attention will be given to equity issues, including gender concerns. This recognizes the need for a more just international economic order in terms of trade for developing countries, and for greater concern for issues related to land tenure, land reform, and the human focus in technology developments.

The CGIAR is only a small part of the global research system and therefore to be effective must work in partnership with all relevant research entities. The evolution of NARS has been significant in many cases, resulting in a much more heterogenous set of partners than was perceived at the initiation of the CGIAR. Similarly rapid developments in biology have altered the desirable linkages with advanced institutes. CGIAR entities must adjust to these changes which will of necessity require movement towards more strategic research because an effective linking role requires institutes to be in touch with both sets of developments. At the same time there is a need to devise or strengthen appropriate mechanisms for dealing with less well developed national programmes, especially in the smaller countries. The implication of this is that simplistic notions of homogeneous programmes which will be relevant to all partners must be questioned. It is therefore necessary for both the components of CGIAR and the CGIAR itself to adopt more flexible research strategies which reflect these and other changes. This would imply a more decentralized approach in priority setting.

In brief, the needs emerging from the changing global and regional contexts call for coordination and targetting of international efforts on:

- ensuring that production potential in more favoured environments is sustained and enhanced because it is the marketable surplus from these areas that will feed the urban and non-farm poor;

- less-favoured environments in which population pressure is high vis-a-vis the potential productivity of the resource base, to provide for sustainable production over time;

- generating new knowledge based on science to increase sustainable productivity and further increase yield potential;

- improved understanding of underlying causes of environmental degradation and options for policy and technology to contribute to sustainable resource management;

- helping remove institutional constraints for effective R&D;

- ensuring that adequate attention is given to the role of agriculture in generating income and employment for self-reliance;

- improved understanding of the policy environment to identify alternative development strategies to promote technological changes for increased productivity of renewable natural resources, leading to poverty alleviation.

The global effort must be complemented by regional efforts targeted at specific constraints and problems shared by countries at the regional level. Thereby: (a) tapping regional research and institutional capabilities and capturing economies of scale in research; (b) providing for coordination of efforts of international institutions and national research systems to address common researchable problems; and (c) for helping to coordinate donor support. The task is to adjust CGIAR priorities and modes of approach to this constantly changing environment.

7.4. The Mission and Goals of the CGIAR

The following mission statement for the CGIAR has been developed by TAC, reflecting the consensus that has emerged in recent years among the various partners in the global research system:

"Through international research and related activities, and in partnership with national research systems, to contribute to sustainable improvements in the productivity of agriculture, forestry and fisheries in developing countries in ways that enhance nutrition and well-being, especially among low-income people."

The above mission statement implies a focus on:

- international research that complements and supports national research efforts;

- complementary activities aimed at strengthening national research capacities such as specialized training and information services, but excluding other development or technical assistance activities;

- satisfying human needs from agriculture, forestry and fisheries, without degrading the environment or the natural resources on which they depend;

- the large numbers of poor people and the importance of technological change in generating new income streams for them.

The ultimate aims are improved nutrition and economic well-being for low-income people, including women, landless labourers and poor consumers in both the rural and urban communities. Research should contribute to food self-reliance by increasing the purchasing power of the poor through lower costs and prices, and greater equity in the distribution of incomes. It should also contribute to the quality of plant and animal products, to sustainability and stability in their supply, and to the prevention of environmental degradation through improved management.

These ultimate aims cannot be achieved solely through research and training. Success depends on many additional factors, such as efficient policies from governments, marketing channels for farm products, input delivery systems, and employment opportunities that bring purchasing power to the poor.

In setting priorities, the relative contributions of different research activities to these ultimate aims must, as far as possible, be explicitly evaluated. TAC considers that priorities can be systematically analyzed and compared using a framework consisting of the following nine goals, to which research activities contribute:

(i) effective management and conservation of natural resources (i.e. land, water, forests and germplasm) for sustainable production;

(ii) improved productivity of important crops and their integration into sustainable production systems;

(iii) improved productivity of important livestock and their integration into sustainable production systems;

(iv) improved productivity of important trees and their integration into sustainable production systems;

(v) improved productivity of important fish and their integration into sustainable production systems;

(vi) improved utilization of agricultural, and forestry, and fish products in both rural and urban areas through improved post-harvest technology;

(vii) improved diets, family welfare and equity (including gender equity), through better understanding of the human linkages between production and consumption;

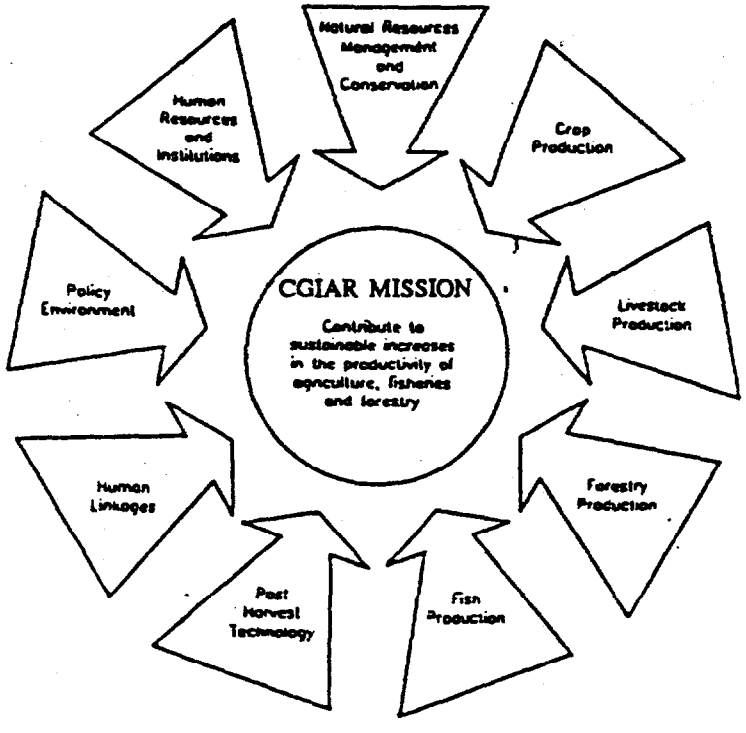
(viii) appropriate policies for increased productivity in agriculture, food, fisheries and forestry and for the sustainable use of natural resources;

(ix) strengthened institutions and human resources in national research systems to accelerate the identification, generation, adaptation and utilization of technological innovations.

Figure 1 illustrates the central mission and the nine goals of the CGIAR.

The level and nature of the CGIAR's future involvement with each of these goals will vary greatly, but all are recognized as essential concerns. The aim is to contribute to the nine goals through research and complementary activities.

Figure 1 The Mission and Goals of the CGIAR



CHAPTER 8 - EMERGING LONG- AND MEDIUM-TERM VISIONS FOR THE CGIAR

8.1. Introduction

Final recommendations on the expansion of the CGIAR System have to be made in the context of the expected evolution of the CGIAR. For not to do so could lead to individual decisions which would be at variance with desired medium- and long-term trends. Thus, before finalizing its recommendations, TAC dicussed at length how it thought the CGIAR might evolve. The Committee first addressed what it saw as emerging long-term trends. Using these as a base, it drafted a possible long-term vision of the CGIAR. That vision, as will be noted, depends heavily on the maturation of national programmes and the development of effective mechanisms of transnational cooperation. TAC is not predicting the long run nor is it advocating a particular structure, rather it is developing a possible scenario which could result if current trends continue. The basic need was to have a possible vision against which to make shorter-term judgements.

The long-term vision suggests a quite different and much smaller CGIAR. Thus, the next obvious question relates to whether there is a plausible path from now to then. TAC addresses this question first in this chapter by developing a medium-term vision which, like the long-term vision, is developed in terms of concepts, activities and mechanisms, not institutions. There are many institutional forms that could accomplish the implementation of desired activities. After presenting specific recommendations on the non-associated centres and forestry in Chapters 9 and 10, the report returns in Chapter 11 to a more explicit discussion of possible evolutionary paths from now to the long run in the context of possible institutional arrangements.

In the long-term vision, global activities remain. In the medium-term vision both global and agroecological activities regionally defined (for these TAC has coined the term "ecoregional") play critical roles. Further, as will be seen in the specific recommendations, TAC sees the need for more sharply defined roles and responsibilities for both types of research activities. Thus the chapter concludes with a more detailed presentation of TAC's views on these research approaches.

8.2. Long-Term Strategic Trends that Seem to Be Emerging

The "long-term" is defined not in terms of a precise number of years, but more pragmatically in terms of the level of maturity of most national agricultural (including forestry and fisheries) research systems in developing countries. Thus, long-term refers to the period when most of the national systems are strong enough to meet their national research needs, by their own efforts or in collaboration with others.

By definition, the first long-term trend which would have a bearing on the role of the CGIAR is the gradual strengthening of the developing country national systems. The rate of this strengthening will vary among countries and across continents. But if the CGIAR is to be judged a success, the capacity of national programmes has to be increased.

Second, and parallel with the first, the number and capacity of regional mechanisms which foster and/or carry out agricultural research are likely to expand substantially in the long term. This is likely to be an outcome of increasing regional collaboration among developing countries and strong interests of donor agencies in building indigenous capacity in the developing world. These regional mechanisms will change as national systems strengthen and greater attention to resource management develops.

Third, as a result of increased capacity of national systems and regional mechanisms and the trend towards increased collaboration, more and more research is likely to be conducted in a networking mode than at present. This would parallel the present use of collaborative research networks in the developed countries. Advances in information technology could facilitate operating in a networking mode.

Fourth, there should be wider sharing of responsibilities for basic, strategic, applied and adaptive research among developed and developing country, transnational, and global institutions.

- Developing countries should be in a position to conduct adaptive research by themselves, with inputs as necessary from other institutions.

- Applied research responsibilities should be increasingly carried out by developing country and transnational mechanisms.

- National institutions and transnational mechanisms will play an increasing role in strategic research. Institutions with global mandates could carry out mostly strategic research, in collaboration with regional mechanisms and national institutions in developing countries and basic research institutes around the globe.

- Basic research should not be viewed as only the province of developed country institutions. Clearly the development of strategic and basic research capacity in developing countries' institutions is absolutely indispensable to their necessary scientific maturity in the long term.

Fifth, international institutions carrying out research at a global level should strengthen partnership relationships with developing countries and regional mechanisms. Those benefiting from such research should increasingly share in agenda setting, responsibility, decision-making power and financing. Regional activities, as necessary, should be financed primarily by the countries that benefit from the work.

Sixth, in the developed countries, research responsibilities (particularly in the germplasm area) are already shifting from the public sector to the private sector. As more basic and applied research in these countries is carried out by private sector institutions, there could be an increasing global need for international strategic research of particular relevance to developing countries.

Seventh, research agendas of nations and regions will continue to be broadened to encompass expanded work on extension, agricultural development and sustainability of natural resources. Research, training and information activities of these institutions will cover the full

spectrum from basic research to farmers' fields. Also, emphasis on production will be increasingly supplemented with work on environmental, institutional and broader agricultural and resource development concerns.

Although the scenario drawn above by necessity must be somewhat speculative, the trends noted reflect an extension of recent developments, coloured by TAC's notions of what might be a realistic scenario. Even if this were to reflect more a "desirable" than a "realistic" scenario, its consideration should be useful in developing structural alternatives that can help achieve this desired future state.

8.3. Role of the CGIAR in the Long Term

Historically, the CGIAR has played primarily a "bridging", a "gap filling", and a leadership role in agricultural research. It has served as a bridge between basic and strategic research institutions in advanced countries and national research institutions in developing countries. It has seen as one of its roles the filling of gaps in the basic-strategic-applied-adaptive research continuum in order to keep that continuum intact at the developing country, region, and international levels. It has been a leader in internationalizing germplasm improvement, in the development of research methodologies, and in training developing country scientists. The transition from this current role to the longer-term vision, which follows, is premised in several points.

First, in the long term the CGIAR must continue to be selective and deal with issues which are truly transnational and global. If the trends noted above are realized, the role of the CGIAR in the research spectrum should be of a different nature than at present because of the likely changes in the roles played by the other actors in the global scene. TAC's expectation is that the number of "gaps" should also diminish with the maturity of national and regional institutions. However, the analysis should be realistic and recognize that there will always be heterogeneitity, i.e. not all national programmes will be equally strong even in the long-run. This is the central issue of the length and character of the menu of research that the CGIAR will need to offer.

Stronger national and regional mechanisms would imply that over the long term the CGIAR should play a much smaller role in adaptive and applied research. This would leave strategic research as an area that can be contributed to by the CGIAR, in collaboration with regional and national institutions. Gaps in international research created by the changing roles of public and private sector institutions in developed countries could also create needs in some areas that may require increased efforts by international institutions with a global mandate, like the CGIAR.

In the long term, a principal responsibility of an institution like the CGIAR should be in the germplasm area. While the work would involve primarily plant germplasm, germplasm work on livestock, fisheries and other living organisms would also gain importance. Collection, conservation, characterization, evaluation and basic manipulation of germplasm would continue to require a global, international and apolitical effort. Research on the use of germplasm

to develop usable crop varieties and animal types, on the other hand, would be handled primarily by regional and national (both public and private) institutions in developed and today's developing countries.

Although it would involve research, germplasm work would be carried out primarily as a service to the global community. Other related services, such as international training and germplasm information dissemination, could also be carried out.

Second, global strategic research related to the expanded research agenda mentioned in point seven in the previous section would require some international focal point, although the research itself could be carried out by many institutions in a collaborative fashion. This research would relate to solving problems of international significance in areas like germplasm, natural resource management, extension, research policy and management and agricultural development. Since the rate at which developing country institutions mature to play stronger roles in strategic research will be uneven, it is not possible to spell out a precise division of labour except to indicate that the CGIAR would be concerned primarily with research problems of global significance.

Third, there may continue to be a need for an international focal point to provide wide-ranging information services to institutions and individuals worldwide. Such a mechanism might maintain and update data banks on insects, pests, diseases, etc., provide abstracting and literature search services, catalogue current and completed major research projects and programmes, and generally facilitate linkages between institutions by helping to match the supply of researchers and research institutions to specific manpower demands from a variety of clients from developed and developing countries.

Thus, in the long term, the CGIAR would function more as an international service institution than at present. Its research role would be limited essentially to strategic research on problems of global significance. It would be supported by all countries and institutions it serves, not only by advanced countries on a grant basis. Its role would shift from development towards facilitation of agricultural research and development on a global basis.

8.4. Possible Long-Term Visions

If TAC is correct in identifying some critical long-term trends, then some characteristics of the CGIAR in, say, 2025 would be quite different. The analysis is limited to identifying activities that are international, i.e. activities which address significant global, continental or transnational problems which exhibit substantial economies of scale, have potential for significant spillover and are important for mature partnership relationships with national programmes. The precise institutional form is difficult to predict. Some additional comments on form are made after enumerating the activities. The bottom line is that if national programmes and ecoregional mechanisms mature, as they must, the CGIAR would be a smaller and more service-oriented enterprise and much less a hands-on applied research organization. The question of how the CGIAR might evolve towards this vision is addressed in Chapter 11 after TAC presents its appraisal of the subject matters and institutions which were involved in the evaluation of the non-associated centres.

Critical long-term activities for possible CGIAR support are discussed in the following sections.

8.4.1. Germplasm

It is clear from the analysis that there will be, for the foreseeable future, an international need for activities in germplasm collection, characterization, conservation and basic genetic manipulation for plants and animals that have transnational and/or global utilization. Included here must be the preservation of biodiversity. The research related to these activities would be likely to be strategic and involve applications of modern molecular biology as well as more traditional scientific techniques. These activities should include as a minimum the following:

(a) annual plants of significance to meeting food needs and sustaining viable farming systems;

(b) perennial plants, particularly trees, of importance to the continuum of land use described earlier;

(c) animals of economic significance, including appropriate aquatic species.

The institutional form of long-term CGIAR support could take several shapes. One would be to foster the narrowing of the focus of existing commodity institutes to germplasm activities and strategic research. There could occur consolidation across commodities to capture more economies of scale. A second approach would be a decentralized mechanism where nodes of basic germplasm work were fostered in a networking mode appropriately located at or near centres of origin. A third approach would be a continuation and expansion of an IBPGR model. Whatever the model, the activities would be highly focused, strategic and provide basic inputs into national programmes around the world.

8.4.2. Natural Resource Management

Despite the fact that natural resource management and its components - agronomy, natural forest management, soils, water, plant nutrition, and agroecological characterization - are often categorized as being "location specific", there are and will remain strategic research issues and environmental problems which will transcend specific production systems and geographical and ecological regions. These include for example basic understanding of soil-water-plant relationships, energy balances, sustainable input/output models, transnational issues of water basins, migratory pests, and soil erosion. Perhaps these could be characterized as issues in the broad research area of the ecological foundations of sustainable production systems. Again strategic research addressed to these issues is international, has economies of scale and should have substantial spillover into national programmes and regional mechanisms (if appropriate).

Again the specific institutional mechanism for international support of these activities could take several forms. There could be a series of agroecologically focused institutes or ecoregional mechanisms linked by a global council. Or there would be a web of professional

networks among national programmes in both developed and now developing countries in the model of international scientific unions. Whatever the specific form, the activities of continuously monitoring, evaluating, and demonstrating usable methodical approaches to major global issues in natural resource management will continue to merit international support.

8.4.3. Policy and Management

The current trends towards the internationalization of commerce, resource management and science will clearly continue and intensify in the foreseeable future. Global interdependence is a growing and permanent reality. Thus the number of major policy issues which are international - e.g. trade, capital investment, and science - will become more complex. In addition, the international ramifications of national policy choice, especially of large countries, will become more critical. Further, as resource constraints - natural, financial and human - become more binding, issues of micro and macro management of research and human capital development resources will be transnational issues. Again the institutional mode could take one of the several forms identified for the earlier issues.

8.4.4. Global Information

With the information explosion and the rapid development of multimedia communication techniques, the need for international mechanisms of collection, evaluation and dissemination of research findings will increase. Improved mechanisms to facilitate international exchange of results, ideas, methods and personnel will be critical. A multitude of mechanisms are possible including an expanded FAO CARIS and AGRIS, or CABI type model. The major issue to be recognized is that these activities too have great economies of scale and significant spillover. These are truly international public goods which will be underproduced if left only to individual nations.

The above is not to suggest that the CGIAR would be the only and lead player in the international scene. Quite the contrary. The proposition is that these activities are critical to the CGIAR accomplishing its goals. The CGIAR could be the lead mechanism in some, an active partner in others, only a financial contributor in still others, and an advocate in the remainder. TAC does not propose a specific model or a clearly defined role. For a time horizon of 30-40 years such precision would be too speculative an activity, but TAC does suggest strongly that these activities will be long-standing candidates for international support.

8.5. A Possible Medium-Term Vision

On first reading, the long-term vision may seem at considerable variance with current calls for increased emphasis on broad issues of resource management on the multiple land use continuum differentiated by agroecological regions. This apparent anomaly is addressed in this section by the presentation of a medium-term vision of internationally supported research which envisions the strengthening of ecoregional international efforts as part of the process of strengthening national

programmes and the development of transnational mechanisms of collaboration. As these occur, international research would increasingly focus on strictly global issues requiring strategic research.

Here TAC presents, again in terms of concepts and activities, one possible vision of CGIAR efforts in the medium term. Discussion of a possible evolutionary path is presented in Chapter 11.

In the medium term the CGIAR could have major activities of two types - global and ecoregional. Global activities would be focused on commodities and selected subject matter areas, such as policy, management, conservation of germplasm and the maintenance of biodiversity. Ecoregional activities would focus on applied and strategic research on the ecological foundations of sustainable production systems, commodity improvement in collaboration with global commodity activities and interfaces with national partners.

TAC sees emphasis on at least the following:

Global Activities

- a series of global germplasm/plant improvement activities on the following groups:
  - cereals, especially rice, wheat, maize and selected other cereals
  - roots and tubers, especially potato, sweet potato and cassava
  - selected legumes and pulses of global or particular regional importance
  - vegetables
  - multipurpose trees
- a livestock activity addressing strategic and applied research issues in an integrated fashion on selected species of global significance
- a fisheries and aquaculture activity on selected topics of international importance
- a genetic resources activity focusing on conservation of genetic resources and the maintenance of biodiversity
- a set of activities addressing strategic policy and management issues of global significance

Ecoregional Activities

Evolving ecoregional activities would focus on coverage of major agroecological zones and ecosystems but TAC does not see the necessity of complete coverage of all agroecological zones. Embedded in these ecoregional activities would be research on natural resource management,

sustainability, the land use continuum including crops, trees and livestock and commodity based farming systems all done in collaboration with national partners. Major ecoregions that could be covered are:

Latin America	— principally humid and subhumid warm tropics and subtropics (summer rainfall)
sub-Saharan Africa	— humid and subhumid warm tropics — semi-arid warm tropics
West Asia and North Africa (WANA)	— semi-arid subtropics (winter rainfall)
Asia	— principally semi-arid and subhumid tropics and subtropics (summer rainfall) — humid warm tropics and subtropics (summer rainfall)
Asia and WANA	— irrigated ecosystems 1/

Other ecological zones such as cool highlands in the tropics and subtropics (summer rainfall) could be covered selectively in conjunction with several of the global activities identified.

TAC has deliberately not specifically identified these activities as institutions, centres or programmes. It is presented as a possible description of the range of activities likely to be of transnational importance. Central to this, in the medium term, would be highly focused global germplasm and subject matter activities collaborating with ecoregional activities and national programmes. Some possible institutional options are presented in Chapter 11.

8.6. Conceptual Notions of Global and Ecoregional Activities

In the preceding discussion of the medium term and in the following recommendations on non-associated centres and forestry, the notions of highly focused global commodity activities and ecoregional activities play a large role. Thus TAC presents a further elaboration here of these concepts.

If it has been possible in the past to marry the requirements of a good commodity research programme with the requirements of a programme directed more broadly towards sustainable production systems, (and there has been variable success in this respect), it is likely to become more difficult, if not impossible, in future, for two main reasons:

First, research directed towards the improvement of sustainable production systems will have to be multi-commodity in its coverage and move into areas of research on land use and conservation that lie outside those normally dealt with in commodity production research.

1/ Irrigated lands are located in several ecological zones so that the term irrigated ecoregion is not suitable. Instead, the term irrigated ecosystems is used.

Second, research directed towards the improvement of commodities will increasingly become more specialized as researchers seek to exploit developments in biotechnology, giving rise to the need for new economies of scale in the provision of the necessary laboratories and equipment.

Consequently, it is difficult to escape from the conclusion that, in future, there will be a need for at least two types of international institutional mechanisms; those with an ecoregional focus and those with a commodity focus, each dependent on the other, and collaborating closely to meet the needs of developing countries.

On this basis, it is possible to envisage two interconnected sets of mechanisms, one based on ecoregions and the other on commodities. The ecoregional mechanisms would act as partners and hosts (sometimes referred to as "relay stations") for all the commodity activities with which they needed to collaborate in that particular ecoregion.

Perhaps the division of responsibilities among existing CGIAR centres, partly on the basis of ecoregions and partly by commodities, is more logical than it has sometimes appeared, but considerable adjustments to existing mandates would be required to make it fully coherent. Indeed, a clear distinction between commodity and ecoregional mechanisms would imply a rational division of responsibilities, but would be viable only with unrestricted collaboration between the two types.

To combine existing CGIAR centres and non-associated centres in a global system following these principles would imply major changes to both sets, and could be contemplated only if the resulting global system could be predicted to serve the needs of the developing countries in more effective ways. Such a prediction must be based both on an analysis of the needs and of the most effective institutional mechanisms.

8.6.1. The Roles and Justification for Global Commodity Mechanisms

The global centres in crop improvement were the original workhorses of the CGIAR. The breakthroughs in rice at IRRI and in wheat at CIMMYT demonstrated the strengths of the global commodity centre concept. A first class multidisciplinary group of scientists was brought together and given a clear mandate and good facilities. Impact from CIMMYT and IRRI was rapid, partly due to the long history behind the original wheat initiative at CIMMYT as well as a considerable background of research on the two crops in developed countries, and partly because the rice and wheat varieties were targeted to more favoured, homogeneous, irrigated environments.

Global commodity mechanisms have clear strengths:

- A clear, direct focus on the crop and its problems.
- A global germplasm collection at hand to be studied for genetic traits of major importance and exploited both as a basis for germplasm enhancement and for developing parental lines of direct relevance to a wide array of problems in developing and developed countries.

- A high quality multidisciplinary scientific team doing strategic research on widely observed problems identified as limiting to global agricultural productivity.

The key ingredient of "lean" commodity mechanisms is the organization of their strategic research along a germplasm axis which includes: collection, conservation, characterization, genetic evaluation, genetic studies - including studies of breeding systems, prebreeding and enhancement - using all available means including biotechnology, and then strong programmes in documentation and information dissemination.

Also vital is international collaboration for the widespread testing and evaluation of germplasm. Specialized networks which make use of known "hotspots" for exposure to pests, diseases and other environmental stresses require continuous and close interaction with regional and national research institutes. Similarly, specialized scientists in these research areas must have ready access to the problems in field situations and to fellow scientists in their own and related disciplines. They need the widest contacts and experience possible to bring to bear on the problems challenging the major identified constraints.

Historically, the global commodity centres have involved themselves in a range of wider activities to help them implement their mandates. They have sought to build up capacity in national systems both to help in the development of their products and also subsequently, to enable national scientists to select and use appropriate Centre products in their own countries. Again, to help their products reach the farmer the centres have helped national systems in essentially location-specific research in agronomy and post-harvest processing. There has been widespread training of national staff at several levels in a range of disciplines. The centres have also invested significant resources in the development of a farming systems approach to research to bring farmers' needs to the agenda of managers and researchers in national programmes.

However, their involvement in these wider areas has sometimes blurred their focus, diverting the attention of management and donors from their central mandate. At the same time, as noted earlier, it has often been these areas of activity that have overburdened some national systems owing to uncoordinated and sometimes duplicated efforts by several centres.

8.6.2. Ecoregional Mechanisms: Role and Justification

Changes in global research priorities, new developments in research methods, and the opportunity to resolve weaknesses in its existing structure justify greater emphasis on an ecoregional approach by the CGIAR and the international community. With regard to changing global research priorities, a primary consideration is the need for research on the sustainable use of resources.

Emphasis on ecoregional research is not new to the CGIAR and its predecessor institutions. The Rockefeller and Ford Foundations established both CIAT and IITA with ecoregional responsibilities and those responsibilities have continued since the CGIAR was established.

The CGIAR also gave mandates to ICRISAT, ICARDA and ILCA that included major ecoregional responsibilities. Each of the five centres named, but especially CIAT, IITA, ICRISAT and ICARDA, has had to deal with a major problem, however, that of mixed mandates; mixed in the sense that each has had both commodity and natural resource management. It has not been easy for these centres to strike a balance between these two kinds of mandates. Indeed, concern has been expressed that research on natural resource management has in some cases become the handmaiden of the commodity research effort.

The IARCs have learned a great deal about natural resource management research in an international context. Much of the farming systems research emphasis in the CGIAR was designed specifically to try to deal effectively with natural resource management research. Today most of the former farming systems research programmes have become resource management programmes.

New tools and methodologies in resource management are now available from the two decades or more of CGIAR research.

In TAC's view, ecoregional mechanisms have several strengths:

- a core of international scientists with in-depth hands on knowledge of the natural endowment of a particular ecoregion; these scientists can be a valuable asset to commodity activities and national programmes;

- the capability to deploy such a core of scientific talent on strategic research of an international nature and related to natural resource management in a given ecoregion.

Soil and water processes are largely managed through the enterprises that farmers find attractive for their farming systems. The crop varieties and animal types, and the techniques used in their production, are the component tools for wider resource management. As components they are shaped by criteria important to the productivity of the whole farm system. The successful amendment of the natural soil and water processes to achieve sustainability depends on the identification of new materials and management techniques for the component enterprises that also improve system productivity.

In recent years, much attention has been given to research methods in an agroecological setting. A systems approach to research has evolved and provides greater confidence that new ventures in resource management research can follow a coherent, manageable approach to problem solving. There have been three main dimensions to the development of a research approach to resource management to which the centres themselves have made significant contributions.

- The agroecosystem represents a more logical level of the systems hierarchy to deal with resource management problems than that provided by a single commodity. Ecologists and geographers have moved strongly into the modelling of ecosystems, usually by computer simulation, to provide a wide framework for more focused efforts.

- One important effort has been by physiologists and soil scientists. They have taken the initiative to elucidate the

effects of variation in soils, water and light on crop growth processes through systems modelling. CABO at Wageningen University in the Netherlands, and IBSNAT at the University of Hawaii, under USAID auspices, lead the application of systems modelling in international agriculture. It is clear that crop growth models have moved beyond the development stage and are finding applications in understanding and manipulating resource management.

- In parallel with these developments there has been a surge of work to understand decision-making in small farmer agriculture. Much of the research effort here has also been through a type of systems modelling that draws the human side into a client-based agricultural research process. The centres have been particularly active in evolving methods for the interaction of scientists and small-farmer clients, as well as developing institutional paradigms for the management of client-orientated research.

Human interaction with the resource base causing land degradation has drawn these approaches together. Future resource management research will be equipped with a new well articulated research approach to provide clear guidelines for its implementation. No such integrated approach was available when the mandates for IITA, ICRISAT, ILCA, CIAT and ICARDA led those centres to pioneer research on resource management and farming systems.

At the strategic level, work will concentrate on understanding the effects of increasing human pressures on the soil, water and biological processes of an agroecosystem. Strategic and applied research will identify a broad range of technical options for sustaining soils, appropriate to the generic economic and social characteristics of the farming populations of the agroecosystem. Through station and farm based experimentation adaptive research will modify those technical options it identifies as appropriate to the circumstances of particular farming communities in the agroecosystem.

An international research effort based on ecoregions could contribute at all three levels. Scientists working on resources research would become experts on the problems of the mandated ecoregion and in their sustainable management. Adaptive research is clearly the responsibility of national systems, but the particular need for ecoregional mechanisms where national systems are weak implies some level of international involvement, if only in training and further method development.

8.6.3. A Provisional Synthesis

It has been noted that national systems must be able to draw from international efforts what they want in terms of national priorities, rather than what is available to them in terms of external priorities. An activity restricted by its mandate to work on specific commodities, for example, is not well placed to provide an effective service broadly related to research on the production of annual crops in the context of soil conservation and watershed management. However, an activity with an ecoregional mandate would be, and there would be no conflict of priorities.

The inference is that, especially with increasing emphasis on environmental issues, there would be many circumstances in which the needs of national systems could be more comprehensively met by ecoregional than by commodity mechanisms. As can be seen, however, the model does not imply the end of commodity activities. On the contrary, it implies a more focused approach to commodity improvement, allowing commodity mechanisms to specialize in those areas where they have traditionally excelled, with the more applied work being decentralized and done in collaboration with ecoregional efforts. Indeed, there are many precedents in the CGIAR System for this type of relationship.

In addition to providing facilities for researchers from other research entities, ecoregional mechanisms would have their own programmes of research in the natural and social sciences related to resource management and production systems, including forestry and agroforestry. They would also need to have strong linkages with policy research. Moreover, they would be well placed to become the lead international focus for a given geographical region or sub-region, thereby exploiting the advantages of ecoregional mechanisms. This is what TAC means by agroecological research, regionally defined. These are what TAC is calling ecoregional mechanisms.

In their relations with national programmes, ecoregional mechanisms would build on the diversity of useful experience already gained from evolving relationships with national systems in the main geographical regions. A major aim would be to move to a set of relationships in which priorities for work with national systems were determined by regional or sub-regional associations of countries or scientists, organized either under the umbrella of a political entity, or as an officially approved steering committee. Contractual relationships required either by ecoregional or by commodity mechanisms, to meet the requirements of their own research programmes, could also be facilitated by the same consultative procedures. Relationships designed primarily to fulfil the development function would be controlled through the regional entity and administered by the most appropriate agency, determined in consultations involving the donor, or donors, the regional mechanism and the lead centre.

8.6.4. Mechanisms and Interactions: Global, Ecoregional Mechanisms and National Systems

Close ties will be required between global and the ecoregional mechanisms where research is needed on problems specific to the region. Regional scientists interacting with the national systems will play a major role in elucidating the needs of the farming systems and agricultural research institutions of the countries of the region. In the area of germplasm research, scientists working at the global level will be in continuous and close touch with this expertise. Global programmes will have outposted scientists in ecoregions working on a daily basis with the biotic and abiotic constraints of the region. Such ecoregional locations will also be primary testing and evaluating sites for international nurseries for the region concerned.

Ecoregional mechanisms would assume an even greater diversity of responsibilities than the original CGIAR centres which were given a regional responsibility in their mandate. Unlike past CGIAR experience their structure, research approaches and lines of management will need

to demonstrate clear acknowledgement of this diversity. Management staff would need to be chosen for their understanding of the different roles of the centre. They must remain aware of the points at which linkages between diverse programmes are important, and remain alert to the pitfalls that threaten collaboration across programmes with different roles.

It is not envisaged that all regional programmes would be implemented through ecoregional CGIAR mechanisms. Where the weakness of the national systems is a decisive factor in their establishment, however, the ecoregional mechanisms would act as intermediaries between the global centres and the countries of the region. The ecoregional mechanisms would coordinate national requirements and ensure that the interactions were tailored to the needs and capabilities of each country. They would also cater for the wider training needs of the countries of the region.

As national systems become stronger, one scenario would see the regional interface with the global activities shifting to other mechanisms, with a greater emphasis perhaps on networking between national programmes and eventually direct interaction between the strong national systems and both global and regional activities. An alternative scenario would see, at some point, the international community handing over the ecoregional mechanism to the host country or to the countries of the region to manage collectively. The pace of any such handover would depend on the political commitment to both research and cooperation in the countries of the region. This would grow out of a better understanding of the importance of new agricultural technology to economic development and of the benefits from the transnational implementation of agricultural research.

CHAPTER 9 - EVALUATION OF SUBJECT-MATTER AREAS AND NON-ASSOCIATED CENTRES

9.1. Introduction

The starting point for TAC's assessment of the non-associated centres was an analysis of the future role of the CGIAR in research in the relevant subject matter areas. The subject matter areas and the relevant non-associated centres are as follows: Natural Resources Conservation and Management, IBSRAM, ICRAF, IFDC, IIMI and IUFRO/SPDC; Crop Protection, ICIPE; Banana and Plantain, INIBAP; Vegetables, AVRDC; Fisheries, ICLARM; Livestock Diseases in sub-Saharan Africa, ICIPE and ITC. Research on coconut was also considered because the 1987 Report on CGIAR Priorities and Strategies recommended that research on this commodity be included in the CGIAR.

A key element in TAC's approach has been the consideration of not only the non-associated centres' programmes but also the programmes of the CGIAR centres in relevant subject matter areas. Ongoing programmes of other international and national research agencies were also taken into account in the assessment. These issues and the recommended institutional options for future CGIAR involvement in research in the various subject matter areas are discussed below. The headings of the final sub-sections reflect the process by which decisions were reached on each non-associated centre. When the decision tree (Annex II) led to clearcut (yes/no) decisions, the sub-sections are titled "Conclusions and Recommendations". Where some activities of the non-associated centre qualified for inclusion in the CGIAR, a sub-section titled "Institutional Options" preceded the one on "Conclusions and Recommendations". Chapter 6 describes in detail the process and criteria used.

9.2. Natural Resources Conservation and Management

9.2.1. Introduction

In its consideration of research on natural resources conservation and management TAC was assisted by a consultant's report and a subsequent desk analysis by the TAC Secretariat. Reports of Fact-Finding Missions to IBSRAM, ICRAF, IFDC and IIMI were also utilized. Other documentation available included the World Bank/UNDP report on Irrigation and Drainage. TAC also consulted the available strategic plans and annual reports of the non-associated centres and referred to the TAC paper on sustainability (TAC/CGIAR, 1988).

Research in this broad area is central to the CGIAR mandate and goals, particularly recently since TAC has strongly emphasized the importance of sustainable agricultural production. Research is needed on agroecological characterization, soil and water conservation and management, land use management, development of production systems for sustainable resource management, plant nutrition, tillage systems, and socio-economic aspects of resource issues. The international research needs are listed in Table 4.3., while the needs and preferred institutional mechanisms for research on factors of production and natural resources are discussed in Sections 6.3.1.5. and 6.3.1.6. and in

Section 8.6.2. TAC had considered an earlier draft of Table 4.3. that included research on fertilizer production technology but decided that research in this area was not appropriate for the CGIAR.

This section includes research topics such as plant nutrition, which does not strictly concern natural resources, because TAC decided that fertilizer research was logically considered in conjunction with resource issues such as soil, water and forests. TAC considered the programmes of ICRAF in the general context of research on natural resources and also in relation to the more specific issue of the CGIAR initiative on forestry and agroforestry. Aspects of agroforestry and ICRAF's and IUFRO/SPDC's activities are therefore considered in this section whereas Chapter 10 presents a full treatment of the issue of the forestry/agroforestry initiative.

9.2.2. ICRAF and IUFRO/SPDC

9.2.2.1. Future Role of the CGIAR in Forestry and Agroforestry Research

TAC recognized that agriculture (including livestock production), agroforestry and forestry constitute a continuum of land use systems with all possible combinations among them. Moreover, agroforestry is not yet fully recognized as a valid set of land use systems with significant potential for resource-poor farmers. Aspects of these land use systems are commonly taught, managed and researched in different arms of universities and Ministries, and their proponents frequently enter into conflict or compete for resources of land, skilled staff and finance. Efforts should be made, particularly in research, to break down such barriers and to maximize investment returns by working on common elements of science and technology and examining interactions among the different elements in the continuum. TAC further recognizes that substantial relevant research is conducted by organizations outside the CGIAR System. These organizations could benefit in various ways through collaborative and contractual arrangements with the CGIAR centres working on agroforestry.

TAC considered that research to develop production systems based on agroforestry for the sustainable management of resources is an important area which meets the criteria for CGIAR involvement. There is also a need for component research, such as tree improvement for a variety of purposes and research on biomass production and soil microbiology. The socio-economic aspects of research on participatory production systems are especially important, and there is a particular need for post-graduate training.

9.2.2.2. Overview of Ongoing Forestry and Agroforestry Research

Within the CGIAR System there is currently only limited research on some aspects of agroforestry. (Note that this overview is primarily concerned with agroforestry; forestry research is covered in Chapter 10). Research on component technology is limited to the collection and evaluation of multipurpose trees at CIAT, IITA and ILCA. At IITA, socio-economic research on agroforestry production systems, particularly alley farming, represents the only significant CGIAR activity in this field. Training is also limited and generally conforms to the pattern of research projects at the various centres.

Agroforestry has blossomed as a development assistance activity over the last decade. These burgeoning activities have few research underpinnings. ICRAF is the global focal point for information, training and methodology development in agroforestry. It has been largely responsible for formalizing, documenting and developing research methodology. Its hands-on research in Africa is complemented by that of IITA, ILCA and ICRISAT, and ICRAF has regular meetings and collaborative network research with these organizations. There are many other institutions outside the CGIAR with small programmes on aspects of agroforestry. It is essential to have one focal point to promote complementarity in agroforestry research across centres and with other institutions.

If agroforestry is defined as an array of land use practices with economic and ecological interactions among crops, livestock and trees, either simultaneously or sequentially, then ICRAF and some CGIAR centres already cover a number of agroforestry research topics. If the definition of agroforestry is broadened to include the role of, for example, savannah woodlands and upland forests in contributing directly (e.g. silvo-pasterism) or indirectly (e.g. watershed management) to agricultural productivity and sustainable land use, then neither ICRAF nor existing CGIAR centres adequately cover such research needs, nor do they cover other aspects, such as the improvement of fruit and nut tree species. Hence, there are several aspects of agroforestry that are not covered by either ICRAF or existing CGIAR centres.

9.2.2.3. Characteristics of ICRAF

The mandate of ICRAF is "to increase the economic and nutritional well-being of the people in developing countries through the integration of woody perennials in farming and related land-use systems in order to achieve higher productivity, sustainability and diversity of output".

ICRAF has evolved over the years from an information council function to hands-on research on systems emphasizing multipurpose tree species (MTP) and the tree-crop-pasture-animal interface. Four Agroforestry Research Networks for Africa (AFRENA) have been established to generate agroforestry practices for specific ecological zones. The research is undertaken by institutions in countries participating in the networks.

ICRAF operates through three separate but collaborative divisions: the Research and Development Division, developing and applying methodology for strategic and applied research at the tree/crop interface; the Collaborative Programme Division, developing and adapting agroforestry practices in selected ecozones, and providing training for national collaborators; and the Communication and Information Division targeting information for a variety of audiences including national programmes and the world scientific community. All three Divisions are contributing to national institution-building in agroforestry.

In a recent publication, ICRAF has presented its strategic plan to the year 2000. The council proposes to increase strategic research on multipurpose trees, sustainability and policy and economic issues. These plans will require a considerable expansion in activities and staff numbers. Annex VI provides more detailed information about ICRAF's planned programmes.

The mandate of ICRAF is defined in terms of research and is generally in line with the CGIAR goals. In general, ICRAF's governance conforms to the CGIAR centre model. However the TAC fact-finding mission noted that it is not clear from the available documents whether ICRAF would be treated as an inter-governmental organization or as some type of corporate body in the event of litigation under the laws of Kenya.

9.2.2.4. Characteristics of IUFRO/SPDC

The IUFRO/SPDC (Special Programme for Developing Countries) is a small operational arm of IUFRO (The International Union of Forest Research Organizations). It was created in 1983 as a mechanism for interacting with national forestry research institutes, for identifying high priority forest research topics of common interest and for mobilizing external aid resources. It has given special emphasis to creation of networks related to improving the productivity of multipurpose trees.

9.2.2.5. Conclusions and Recommendations

While TAC saw arguments for bringing ICRAF into the CGIAR system, it also had reservations. TAC noted that ICRAF is making valuable contributions to research on agroforestry. However, as an institution focused solely on agroforestry systems, ICRAF lacks the direct support of, and interaction with, both component forestry research and the crop-related and livestock-related research of the CGIAR centres. TAC also took into account the proposed CGIAR initiative in forestry research, the desirability of avoiding duplication in areas such as tree improvement, and evolving concepts of a desirable institutional structure for a future CGIAR System.

TAC therefore recommended the admission of ICRAF, but only if it was prepared to cover those aspects of forestry and agroforestry research considered suitable for CGIAR involvement. Chapter 10 discusses the TAC recommendations and strategy in detail.

In its stocktaking of IUFRO/SPDC as an integral part of the non-associated centres review, TAC concluded that IUFRO/SPDC should not be incorporated into the CGIAR System for two main reasons:

(i) it is not a research centre as such (it only has two permanent staff)

(ii) its mode of operation is entirely that of acting as a "facilitator" or "broker" in mobilizing support for research networks. It does not carry out research itself.

However TAC recognized that the database information dissemination and training aspects of IUFRO's work programme are of direct relevance to the CGIAR. If IUFRO/SPDC decides to phase out this work then these IUFRO activities and its ongoing work programme should be absorbed by the proposed CGIAR forestry/agroforestry centre which is discussed in Chapter 10.

9.2.3. IBSRAM

9.2.3.1. Future Role of the CGIAR in Soils Research

The effective management and conservation of soil resources is one of the key requirements for sustainable agricultural and forestry production. Research is needed to characterize soils as part of a general ecological framework that can be used to assess potential land use. International research in this area is essential to develop methodologies and to utilize the ecological database in conjunction with farming systems and population data for research planning and priority setting.

The threats posed by various processes of land degradation to sustainability in different regions of the developing world have been described in Chapter 3. Soil acidity, salinity, nutrient exhaustion, erosion and compaction constitute the most serious soil constraints to production. Research is needed to define the scope and importance of these problems, devise soil management technologies to overcome them and evaluate these technologies in the context of productive land use systems. It should be noted that soils research is needed in both favoured and less favoured areas.

The research needed is long term and requires a decentralized, multidisciplinary approach. The approach recommended by TAC is described in Chapter 8.

9.2.3.2. Overview of Ongoing Research on Soils

Soil as a productive resource must largely be studied in situ. Soil related policy, for example on soil conservation, is essentially a national domestic issue. It is not surprising, therefore, that most soils research has been done in national programmes and this mostly in the more developed countries. In many less developed countries research activities have been modest, often supported by bilateral donors and backstopped by classification and policy work by FAO.

A number of CGIAR centres have active soil research programmes. These include resource inventory work, strategic research on soil chemistry and soil physics, and major programmes in soil fertility concerned with macro and micro nutrients as well as toxicities. The research on toxicities is closely linked to centre crop improvement programmes. Research on soil conservation has been conducted at several CGIAR centres but has been modest relative to the size of the problem of soil erosion in less developed countries. It is probably the case that soils work in the CGIAR System is too limited and insufficiently coordinated.

IBSRAM was founded with the primary objective of promoting and assisting applied soil research. Ongoing and proposed activities are heavily focused at the farm level to fill perceived gaps in CGIAR programmes through adaptive soil research, bridging IARCs and NARS. These activities to some extent complement current work supported by the CGIAR, as they extend beyond the central mandates of the IARCs.

TAC noted several gaps or areas in which research should be strengthened. Research issues related to soil conservation and

management seem to be covered to a greater or lesser extent by the IARCs and other institutions outside the CGIAR System (e.g. Tropsoils, the International Soil Tillage Organization, national soil conservation organizations). The gaps that research in the CGIAR may need to cover concern rates of soil degradation in the tropics under different types of land use, nutrient economy in the humid tropics, and biological methods of soil conservation.

9.2.3.3. Characteristics of IBSRAM

IBSRAM was created in 1983 to "promote and assist applied soil research into the identification, development, use, management and protection of soils and lands for food production and other agricultural or agroforestry purposes, so as to enhance economically sustainable production in developing countries". IBSRAM's programmes, strategy and modes of operation are described in detail in the report of the TAC fact-finding mission.

IBSRAM does not undertake research itself but promotes research on soil management problems by national programmes in developing countries and channels funding to them for this purpose. Through a series of global and regional workshops on soil constraints, national programmes have been organized into networks coordinated by IBSRAM to focus on a few major land management problems.

To varying degrees dependant on donor support, these networks have been established on a regional basis in Africa and Asia. The network members undertake a common core experiment designed at inaugural network workshops by national programme scientists in collaboration with scientists from the CGIAR centres and other experts in the field; these include biometricians, social scientists, agronomists and soil scientists. IBSRAM advocates a multidisciplinary approach, but does not itself employ a critical mass of multidisciplinary scientists. The main emphasis of the research is on soil and crop management practices designed to overcome the key constraints which are the topics of the network, e.g. management of vertisols, management of acid tropical soils, land development and management in the humid tropics, and management of clay soils after rice.

The field research conducted by national programmes in the core experiments is adaptive research, but some of the detailed measurements, at the site and the associated satellite experiments, designed to address particular issues, amount to applied research. As the networks identify gaps in more basic understanding of soil management issues, IBSRAM would like to become involved in strategic research, presumably through contracts to universities and other advanced institutions.

IBSRAM has been active in the publication of workshop proceedings, and recently published the first of a new series of soil management abstracts. IBSRAM also publishes methodology manuals tailored to the needs of particular networks and uses these in the training courses which precede each network programme. These activities are designed to strengthen the capability of national programmes, a central function of IBSRAM.

IBSRAM's activities and modes of operation are based primarily on adaptive research in national programmes conducted through enabling

networks. As the Board was created "to promote and assist applied soil research" rather than to conduct research itself, its mandate is different from that of the CGIAR centres. IBSRAM conforms to the general CGIAR model as regards its governance, and has recently signed a headquarters agreement with the Government of Thailand.

9.2.3.4. Conclusions and Recommendations

TAC noted that IBSRAM's programmes are at an early stage of development and have considerable potential to strengthen national research and extension programmes in soil management. However, TAC decided to recommend against the inclusion of IBSRAM in the CGIAR for the following reasons:

- TAC did not consider heavy involvement in adaptive research and development activities with national programmes to be a desirable evolutionary trend within the CGIAR System; and

- Looking to the future, TAC saw an increasing need for strategic research on soil conservation and management to be conducted in a broad agroecological context, including productivity research and other aspects of research on resource management.

TAC recognized, however, that there is a compelling case for strengthening applied and strategic research on soil conservation and management within the CGIAR System. In addition, communications and linkages among soil research programmes should be enhanced through the type of network mechanisms being proposed for the crop protection field in Section 9.3.5. Soil research would best be enhanced through such a mechanism and through expanded programmes integrated into the programmes of existing CGIAR centres, especially those that evolve towards becoming ecoregional centres as proposed in this report.

Such centres would promote and back-stop collaborative networks with national programmes in areas of research consistent with priorities set by national and transnational organizations. In this way the research in national programmes currently supported by IBSRAM could be designed to cover a broader spectrum of research related to the conservation of natural resources, closely supported by an integrated programme of strategic research.

9.2.4. IFDC

9.2.4.1. Future Role of the CGIAR in Research on Fertilizers

The contribution of fertilizers to the grain production gains of the green revolution have been estimated to be as high as 50%. However, there is much room for improvement in the efficiency of fertilizers, particularly nitrogen. A related problem in intensive production systems in high potential areas is that increased use of high-analysis nitrogen and phosphorus fertilizers leads to deficiencies of potassium, sulfur and some micronutrients. The careful monitoring of such deficiencies is essential to ensure that yields are not affected.

In the rainfed uplands in Africa, Latin America and Asia, research to develop sustainable systems with low levels of external

inputs must be given high priority. Strategic research by international centres is needed to delineate the nutritional constraints in major agroecological zones and develop packages of technology which can be validated through adaptive research by national research agencies.

In the areas with low and erratic rainfall the adoption of even low fertilizer inputs by farmers will depend a great deal on their perception of risk. Research is needed to analyze the risk of poor fertilizer response in rainfed areas. Such analyses may lead to risk reduction through adjustments in plant population and delayed fertilizer application. Computer simulation of crop response to fertilizer is a powerful tool in such studies, in particular when historical weather data can be used in the analysis of probabilities.

For high-potential areas with assured water supplies, the research strategy is quite different. Methods of identifying nutritional constraints, correcting them in an efficient and profitable way and monitoring long-term changes in the soil and environment are needed. In research on fertilizers for both high- and low-potential areas, methods for enhancing the supply of nutrients from the soil and from crop residues, manures and nitrogen fixation should be considered. Integrated nutrient management is particularly important in rainfed areas.

Effective agronomic research on fertilizers requires careful consideration of the economics of the fertilizer practices or products under study. The socio-economic environment of the target farmers should be taken into account, e.g. the availability of cash to buy inputs and the potential for credit and other schemes to encourage fertilizer use. Thus a multidisciplinary approach involving soil scientists, agronomists, plant breeders and socio-economists is needed. TAC's views on this issue are presented in Chapter 8.

9.2.4.2. Overview of Ongoing Research on Fertilizers

All of the CGIAR centres responsible for crop research are active in plant nutrition work which in some centres is closely linked to crop improvement programmes. Some centres are selecting germplasm for tolerance of low nutrient status, e.g. rice tolerant of low zinc, nitrogen and phosphorus studied by IRRI. Most centres are supporting agronomic research on fertilizer management and some include economists in work on fertilizer response. At ICARDA a programme on soil testing to determine fertilizer needs has been established in cooperation with national programmes in the region.

For upland agriculture, low external input systems, utilizing rock phosphate and/or biological nitrogen fixation by legumes, are under study at CIAT, ICARDA, ICRISAT, IITA and ILCA. Food, forage or shrub legumes are used in these systems and the Rhizobium requirements of these plants is a common research theme. In semi-arid areas, the nitrogen-water interaction in crop production is a theme of ICRISAT and ICARDA research. Crop simulation models are used to analyze this interaction and the risk of fertilizer response.

For wetland systems, biological nitrogen fixation by algae, Azolla and other organisms and the efficient management of phosphorus, nitrogen, potassium and micronutrient fertilizers are major activities

at IRRI and are also being studied at WARDA. The role of crop residues is also being studied and IRRI has emphasized research on integrated nutrient management more recently and has expanded research efforts on green manures.

Some of IFDC's work, such as that in fertilizer production, complements the work of the CGIAR centres. However, TAC did not see this as an appropriate activity for the CGIAR. The outposting of IFDC agronomists to a number of CGIAR centres has complemented and strengthened CGIAR activities in plant nutrition. However, TAC saw an increasing likelihood of IFDC's work on fertilizer use and plant nutrition being duplicated by the centres, particularly in view of the intention of the centres to strengthen their activities in this area in response to the increased emphasis on sustainability. The centres' approach would involve consideration of both organic and chemical fertilizers, whereas IFDC's mandate is largely restricted to the latter.

TAC considered that many aspects of research on plant nutrition were being quite well covered and supported by a number of international and national agencies working in this field, in addition to the CGIAR centres and IFDC programmes.

9.2.4.3. Characteristics of IFDC

Established in 1974 in Muscle Shoals, Alabama, IFDC focusses on the research, development and transfer of appropriate fertilizer technology and related know-how that can increase and sustain food and agricultural production in developing countries at the lowest possible cost. IFDC programmes in research, technical assistance and training are designed to achieve three major purposes:

- to improve efficiency in fertilizer production, procurement and marketing, and to increase the availability of appropriate fertilizers to farmers at the lowest possible cost while emphasizing the use of indigenous raw materials;
- to increase fertilizer use efficiency in food production;
- to assist in the training of personnel needed in developing countries in the production, marketing and use of fertilizers.

As described in the report of the TAC fact-finding mission to IFDC, the centre has a long list of research achievements and activities and has recently expanded its African programmes through the establishment of an Africa Division based in Lomé, Togo.

Research accounts for 52% of the budget at IFDC. According to IFDC, the research effort is divided evenly between strategic, applied and adaptive research. Much of the research on fertilizer efficiency is organized to focus on three basic nutrients; nitrogen, phosphorus and sulfur. Collaborative arrangements with CGIAR centres and national programmes, commonly organized into networks, have been made to handle the agronomic aspects in the field. IFDC's comparative advantage lies with its unique multidisciplinary teams of chemical engineers and agronomists. The engineers and fertilizer technologists are able to characterize indigenous phosphate deposits in the developing countries, devise low-cost processes for treating the output of such deposits and

to develop improved nitrogen and sulfur fertilizer products. In addition, IFDC has developed a capacity for research on socio-economic and policy aspects of fertilizers and on modelling crop responses to fertilizers.

IFDC has recently initiated four networks in Africa. Probably because a number of the collaborating national programmes are relatively weak, these networks are generally enabling networks. In the fertilizer efficiency area, the networks involve testing and evaluation of new indigenous fertilizer sources and management practices in multi-location trials. A recent feature of the experiments in Africa is the consideration of aspects of nutrient cycling from organic nutrient sources as well as chemical fertilizers. IFDC's move into this area and into research on aspects of environmental pollution is foreshadowed in the centre's 10-year plan.

In addition to its involvement in the core research programmes aimed at improving fertilizer use efficiency, the IFDC Fertilizer Technology Division is heavily involved in one-off activities which involve some research on fertilizer processing but are more appropriately described as technical assistance. For example, a private- or public-sector fertilizer producer may contract IFDC to develop or test an improved process for beneficiating an indigenous phosphate ore. Such activities are short-term in nature and are done by IFDC on a reimbursable cost basis. The Fertilizer Technology and the Outreach Divisions take major responsibility for the various technical assistance projects, which have totalled 300 since the centre's establishment in 1974. These projects have covered aspects of fertilizer use, fertilizer marketing and distribution, and fertilizer sector planning and institutional development, in addition to the fertilizer production area mentioned above.

IFDC has a major training programme which covers aspects of fertilizer use, production and marketing. Both general (group) and specialized (customized) training programmes are organized. The general programmes are held on a fee-paying basis to help defray IFDC's costs. Some of the training materials are published and are widely used as source materials. IFDC has published a number of technical bulletins, reference manuals and selected proceedings of IFDC workshops. Research results are widely published in international scientific journals. IFDC staff have access to literature on all aspects of fertilizers through the library of the National Fertilizer Development Centre of TVA at cost.

A major difference between IFDC and the programmes of the CGIAR centres is IFDC's technical assistance programme. For the most part IFDC's technical assistance is provided on a reimbursable cost basis and is broad in scope, ranging from fertilizer production to institutional development. Special projects, which include technical assistance, constitute 60% of IFDC's budget.

IFDC's mandate relates mainly to developing improved fertilizers and promoting fertilizer use. Furthermore, IFDC is concerned with a single factor of production. TAC noted that IFDC did not include other sources of nutrients besides chemical fertilizers in its mandate, but was aware that some research on organic fertilizers had been started at the IFDC centre in Lomé. The governance of IFDC conforms to the CGIAR model.

9.2.4.4. Conclusions and Recommendations

While recognizing that IFDC had undertaken valuable work in the field of crop nutrition, TAC saw no compelling reason for admitting an institution of this type into the core-funding mechanism of the CGIAR. TAC considered that research on crop nutrition could be conducted effectively both within national programmes and at several of the multidisciplinary centres already funded by the CGIAR.

Among IFDC's other activities, TAC considered that technological research on fertilizer production was beyond the scope of the CGIAR, although specific aspects of such work might well be undertaken collaboratively with CGIAR Centres. Moreover, IFDC's involvement in technical assistance projects through competitive bidding represented an activity that TAC regarded as inconsistent with the preferred modes of operation of CGIAR centres.

Although TAC recognized IFDC's record of achievements in research and development activities, it decided not to recommend admission of the centre to the CGIAR.

9.2.5. IIMI

9.2.5.1. Future Role of the CGIAR in Research on Irrigation Management

The critical role played by irrigation in agricultural production in developing countries, and particularly in Asia, is widely recognized but even greater benefits would flow from this input if scarce irrigation water resources were more efficiently managed. In many cases, irrigation management agencies are unable to distribute water equitably, reliably and efficiently.

The major constraints are economic, political, sociological and institutional rather than technical. TAC estimates suggest that the application of existing knowledge could increase the efficiency of water use by 30-150%. Thus, the dissemination of available information, the training of personnel responsible for the management of irrigation systems and the strengthening of the institutions responsible for irrigation management and research must be given high priority. National programmes will therefore benefit from support coordinated by international Centres but have to take primary responsibility for developing their own national capacity in the areas indicated.

Research on socio-economic aspects of irrigation management are critically important, considering the nature of the problems outlined above. Information is needed on the institutional structures responsible for irrigation management, the costs of maintaining and managing irrigation systems, the system of charging for irrigation water and the attitudes of farmers and irrigation system managers to irrigation management and use. At the international level, research is needed on the policy of irrigation development and the role of irrigation development in food production.

9.2.5.2. Overview of Ongoing Research on Irrigation Management

In the area of water management, IRRI, WARDA and CIMMYT have some work, but the organization and management of irrigation systems are not covered, nor are the technological aspects of irrigation water management. This last area, which is the subject of a recent initiative of the World Bank and UNDP, was considered by TAC to be largely outside the scope of the CGIAR. IFPRI has conducted research to analyze the important role of irrigation in relation to food policy.

TAC found that IIMI was filling a significant gap in subject matter coverage within the CGIAR System and that its work complemented rather than duplicated the work of several other IARCs. IIMI's programme is concerned with seven main themes covering institutional and management aspects of irrigation. The institute is undertaking literature reviews on these themes and is attempting to focus research in its numerous country projects and networks on various aspects of the seven main themes.

9.2.5.3. Characteristics of IIMI

IIMI was established in Sri Lanka in 1985, with a mandate to strengthen national efforts to improve and sustain the performance of irrigation systems in developing countries, through the development and dissemination of management 1/ innovations. The strategy of IIMI is described in their publication "Managing Irrigation in the 1990s". IIMI undertakes multidisciplinary research projects with a systems approach to irrigation management. The institute's strategy is to develop management innovations through research and help national irrigation management institutions to originate, implement and adapt such innovations independently under national and local conditions.

The core research of IIMI has been termed "thematic research" and is concerned with seven main areas:

- Institutions for irrigation management
- Management of change in the institutions of irrigation
- Management of water resources for irrigation
- Management of irrigation facilities
- Management of irrigation organizations
- Management of financial resources for system sustainability
- Management of irrigation support services for farmers.

Research in these areas includes aspects of the management of organizations, of financial resources and of institutional change, as well as broader socio-economic and, to a lesser extent, technical aspects of irrigation management. The extent to which these themes are actually researched depends largely on the levels of core funding and the time and facilities available to headquarters staff to undertake field operations in Sri Lanka.

1/ IIMI defines irrigation management as the process that institutions or individuals employ to set objectives for irrigation systems; establish appropriate conditions; identify, mobilize and use resources to attain these objectives, while ensuring that these activities are performed without adverse effects.

TAC noted that IIMI operates largely through a series of country projects but that this was necessary in order to undertake research on the organization and management of irrigation systems. The technical assistance aspects of this work total an estimated 15% of IIMI's budget. On the other hand, the thematic research of IIMI is international in nature.

IIMI does not have a formal mandate but states its mission as follows: "to strengthen national efforts to improve and sustain the performance of irrigation systems in developing countries, through the development and dissemination of management innovations". The mission of IIMI therefore conforms more with that of ISNAR than with those of the commodity centres in the CGIAR. The governance of IIMI conforms to the CGIAR model.

9.2.5.4. Conclusions and Recommendations

In considering the case for the admission of IIMI to the CGIAR, TAC noted the following issues:

The substantive difference between IIMI's mission and the mandates of the CGIAR commodity centres is associated with major differences in its activities and modes of operation. The closest parallel within the CGIAR System is the mandate of ISNAR. Both undertake research on institutional, organizational and management problems under actual operating conditions. For ISNAR, this means working in national research systems; for IIMI it means working in irrigation systems.

The term "irrigation management" as used by IIMI is therefore a substantially different concept from those such as "soils and water management", sometimes referred to as "factor" research. Accordingly TAC does not see IIMI as an institute working on a single factor of production to any greater or lesser extent than it might view ISNAR in this way. Consequently, in TAC's evolving terminology, IIMI will be regarded, along with ISNAR and IFPRI as a "subject matter" centre.

TAC also noted that there is little research in these areas outside the IIMI programmes and, as in the case of ISNAR, IIMI's role is not one that could readily be subsumed within the portfolios of existing CGIAR centres. It requires a different set of disciplines and a different paradigm. It is the combination of all of these considerations that justifies admission of IIMI as a stand-alone centre within the CGIAR System.

In recommending IIMI's incorporation into the CGIAR, TAC considers the following issues to be important to the work programme:

- the quest for equity and poverty alleviation in the organization and management of irrigation systems should remain a central tenet of IIMI's mission;

- there should be an enduring emphasis on thematic research to identify strategic management principles;

- the dissemination of advances on irrigation management should remain a low proportion of the total effort, since this is

primarily the responsibility of the national extension and irrigation institutions.

Over the long run, TAC saw two possible developments capitalizing on experience with management research in the CGIAR System. First, there may be opportunities for sharing some skills and resources with ISNAR, particularly if ISNAR should move to a more decentralized mode of operation. Second, IIMI's experience in the more equitable management of water as a common resource might be extended into the management of other common property resources.

9.3. Crop Protection

9.3.1. Introduction

In its consideration of crop protection research, TAC was assisted by a desk analysis prepared by the TAC Secretariat, the report of a TAC Fact-Finding Mission to ICIPE, a consultants report, the recommendations of a TAC Panel on Crop Protection Research, and the draft report of the ACIAR Task Force on Integrated Pest Management. Other documentation available to TAC included the strategic plans, the medium-term programmes and external review reports of CGIAR and non-associated centres with major research activities in crop protection.

TAC concluded that crop protection research concerned a wide spectrum of harmful and beneficial organisms, and that the CGIAR's multidisciplinary approach may well need to be broadened in the future, rather than narrowed. TAC considered the main research areas to be: biology and ecology of major pests, components for pest management for crops of economic importance, and inter-relationships among components for pest management.

9.3.2. Future Role of the CGIAR

TAC considered that concepts and emerging technology in crop protection offered exciting possibilities for complementing the IARCs traditional emphasis on host-plant resistance to pests. These opportunities include:

- biological control of major pests
- pest-forecasting techniques
- cultural practices to reduce pest attack, and
- integrated management practices.

All of these techniques could, individually or collectively, be used to lessen the damage caused by insects, diseases, weeds and foraging animals (referred to as pests). Moreover, recent advances in molecular biology provided opportunities to enhance biological control agents genetically, improve the understanding and deployment of host-plant resistance, and develop new diagnostic tools for pest identification.

To realize these opportunities, research emphasis must be given to pest biology and ecology. Research was also needed on how best to use specific tactics such as biological control, and how best to integrate multiple tactics into management systems. These research

topics were seen as international in nature and relevant to the scope and goals of the CGIAR.

Efforts in crop research should lead to ecologically sound pest management practices and should also help to ensure that crop production could be sustained in the long term. Future research at the IARCs should therefore give greater emphasis to exploiting these opportunities.

9.3.3. Overview of Ongoing Crop Protection Research

TAC noted that there were considerable differences in the levels of research on crop protection among CGIAR centres. While there had been significant contributions through research in biological control, as in the case of cassava mealy bug, in general the major contributions of the centres have been in host-plant resistance. These contributions were considerable and important, but this focused activity had, in some instances, been at the expense of efforts to develop other approaches to pest management. Expanded research was now needed on broader aspects of pest management; especially strategic research on the components of pest management as well as on the underlying biology and ecology of crop pests.

With continuing intensification of cropping practices, new or more difficult pest problems could be expected to emerge. More commitment to pest management research was therefore needed. This would require the efforts of many organizations, including the CGIAR centres. It would be appropriate for the centres to contribute to this research, not only because it could lead to significant advances in the production of their mandated crops but also because the centres have a recognized comparative advantage in crop productivity research.

Pest problems were, by their very nature, dynamic. Care and flexibility would be required by the centres to ensure that emerging pest problems were quickly and effectively tackled.

9.3.4. Characteristics of ICIPE

TAC considered that ICIPE contributed to crop protection only through the discipline of entomology, and had a focus on African problems. As such it did, in some areas, complement the work of other CGIAR centres, including IITA and, to a lesser extent, IRRI and ICRISAT. The emphasis of its more basic work was on insect science, including sensory physiology, cell biology, chemistry and biochemistry. In terms of African coverage, ICIPE's programme in the biology, ecology and management of insect crop pests complemented, to some extent, that of IITA, which had a greater West and Central African focus.

Current research at ICIPE that dealt with problems also being addressed at CGIAR centres was largely collaborative, a mode of operation which should minimize duplication. However, because of competing demands for research among donors supporting ICIPE and other institutions operating in Africa, there was increasing scope for duplication. This was particularly likely to occur in areas, such as breeding for host-plant resistance, where ICIPE had little comparative advantage (except in studying host-plant resistance in relation to insect behavioural mechanisms).

The current modes of operation of ICIPE largely conform to those considered acceptable for CGIAR centres. It has an appropriate balance between strategic, applied and adaptive research, and has established innovative mechanisms for strengthening national research programmes. ICIPE was originally established as a centre of excellence to carry out basic research on insect endocrinology and physiology. Later, "ecology" was substituted for "endocrinology" in its title. Over the years, partly as a result of donor demand, it has become more involved in integrated pest management research and has made a shift towards applied and adaptive research. It places heavy emphasis on training African entomologists. ICIPE is essentially a disciplinary centre devoting about one-third of its budget to entomological aspects of crop protection.

Although ICIPE has legal status in Kenya as an inter-governmental organization, its charter was drafted in such a way that the powers and responsibilities of governance were vested in its Governing Council. ICIPE has modelled its council on the typical "Board of Trustees" of CGIAR centres and, in TAC's view, ICIPE conforms to the preferred institutional nature of a CGIAR centre with respect to its governance.

9.3.5. Conclusions and Recommendations

ICIPE presented a difficult case for TAC. Of its four research programmes - crop pests, livestock ticks, tsetse and medical vectors - only the crop pests programme was considered in this analysis. Consequently, the conclusions on ICIPE as an institution for possible CGIAR support have been based largely on this programme. The ticks and tsetse research programmes were considered in the analysis of livestock diseases research (Section 9.7.), whereas the human vectors programme was not considered.

TAC concluded that there was no compelling evidence to move away from the notion that crop protection research should remain distributed among CGIAR centres as a component of their multi-disciplinary programmes. In TAC's view, a specialized CGIAR centre on crop protection research would lead to polarization and fragmentation of research, as well as duplication of efforts. However, centralized facilities for basic and strategic entomological, pathology and weed research at specialized institutions in the developing and developed countries could continue to support the evolving needs of the CGIAR centres.

TAC recognized that ICIPE had evolved as a centre of excellence in insect science. Nonetheless, it concluded that, as an institute, ICIPE did not fit into the evolving pattern of CGIAR activities. Consequently, TAC does not recommend ICIPE for inclusion in the CGIAR System.

TAC was anxious, however, that these recommendations should not be misconstrued. They were based on TAC's view that crop protection research was best conducted within the broad framework of crop production research. The CGIAR's multidisciplinary approach may well need to be broadened in the future, rather than narrowed. Nonetheless, TAC saw continuing opportunities for ICIPE's involvement in collaborative and contractual arrangements with CGIAR centres on specialized aspects of insect biology and ecology.

TAC further concluded that the areas of pest management identified as being inadequately covered by existing international institutions included: strategic research on the biology and ecology of major pests, identification and evaluation of biological control agents; and research into inter-relationships between the components of pest management. Research in these areas could be enhanced in two principal ways. Firstly, there needs to be more investment in strategic crop protection research at the CGIAR centres, but this work needs to be well integrated with the overall programme(s) on crop production. Secondly, there is a need for better communication and linkages between crop protection research at CGIAR centres and at other institutions.

TAC considered that one approach for promoting increased crop protection research would be to encourage the development of an IARC crop protection research network. Such a network would be an informal grouping of scientists with common interests. It would provide the following benefits:

- a linkage mechanism for crop protection disciplines compatible with the multidisciplinary orientation and structure of the IARCs. The recognized strength of the IARCs was their interdisciplinary approach to crop research. A network approach to crop protection would enhance this strength;

- research findings in crop protection could be more easily integrated into cropping systems, as the present centre structure would be augmented through new knowledge;

- it would give all centres access to new technology and knowledge in crop protection;

- better communication within the scientific community by providing points-of-contact at institutions recognized for their scientific excellence;

- enhanced research collaboration through linkages with other research programmes outside the CGIAR membership;

- a broadening of interest in crop protection research on a global scale;

- better reporting of results to the international scientific community and, consequently, better application of those results to agriculture worldwide;

- a mechanism that could evolve, if required, into a more formal structure, such as a centre-without-walls.

The research activities to be undertaken should be in the areas identified above (Section 9.3.2.). The research should be demand-driven through continuous feedback from national and relevant international systems, allowing for timely reaction to emerging problems. The network should be given responsibility for reviewing the research undertaken, identifying needs and proposing new lines of work.

To help to meet the needs of strategic research in crop protection, the CGIAR may need to provide specialized research facilities at its ecoregional centres. Such facilities could be used by

scientists working in that ecoregion on a continuing basis, or by scientists on secondment from commodity centres.

9.4. Banana and Plantain

9.4.1. Introduction

In its consideration of banana and plantain research, TAC was assisted by desk analyses prepared by the TAC Secretariat, the report of a TAC Fact Finding Mission to INIBAP and the recommendations of a TAC Panel on Banana and Plantain. Other documentation available to TAC included the strategic plans of INIBAP and IITA, the medium-term programmes of IBPGR and IITA, the proceedings of conferences and symposia organized by INIBAP and the latest annual reports of IITA and INIBAP. TAC concluded that banana and plantain were highly eligible for enhanced CGIAR support because they are of great economic importance especially for resource-poor farmers in many developing countries. Moreover, research on these crops has been neglected. TAC considered the main research areas to be genetic exploitation, germplasm enhancement, pathology, and agronomic studies.

9.4.2. Future Role of the CGIAR

On the basis of the information available to TAC, banana and plantain are considered to be of far greater socio-economic importance in Latin America and the Caribbean, sub-Saharan Africa, and Asia and the Pacific than the present limited research effort would suggest. Furthermore, in its 1985 review of CGIAR priorities and strategies, TAC identified banana and plantain as meeting the main criteria for CGIAR support (TAC/CGIAR, 1987). Since banana and plantain are grown throughout the humid and subhumid tropics, the CGIAR system is well placed to complement national research programmes and to coordinate the international research component.

Banana and plantain production is inherently sustainable and conservative of soil. The crops are non-seasonal and therefore have an attractive labour distribution. They are also generally marketed locally. TAC considers the main area requiring international strategic research to be the exploitation of genetic resources. The understanding of indigenous banana and plantain production systems is also considered to be important because this would allow the genetic improvement programme to be directed at the right objectives. Strategic research on the major diseases of banana and plantain would be essential in order to ensure the development of disease-resistant cultivars.

9.4.3. Overview of Ongoing Banana and Plantain Research

The mandate of IITA includes plantain, but not banana. Since 1987, IITA has established a plantain breeding programme dedicated almost exclusively to breeding for resistance to black sigatoka and other diseases as well as for superior agronomic characteristics. IITA has a large collection of banana and plantain germplasm, primarily from Africa but with many recent introductions from other parts of the world. It has produced a large number of new hybrids of both plantain and

cooking banana with resistance to black sigatoka. As a result of these developments IITA considers that an early solution to sigatoka is now in sight. It is planning to include research on other pests, particularly weevil and nematodes.

IITA is in the process of testing the uniqueness of the Onne sub-station (where banana and plantain can set seed) relative to its new humid forest sub-station at Yaounde (Cameroon), where an expanded programme might be based. Although IITA's research activities to date have been confined to humid and subhumid West and Central Africa, the new hybrids have importance outside the West and Central Africa region.

IBPGR is the only other CGIAR centre with a relevant mandate, including banana as well as plantain. IBPGR is active in the collection, characterization, conservation and safe exchange of Musa germplasm.

There are four non-CGIAR institutions with major research programmes on banana and plantain:

- INIBAP
- Fundación Hondureña de Investigación Agrícola (FHIA), Honduras
- Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), Brazil
- Centre de Coopération Internationale en Recherche Agronomique pour le Développement/Institut de Recherche sur les Fruits et Agrumes (CIRAD/IRFA), France.

INIBAP has established three regional networks: one each for West Africa, East Africa, and Latin America and the Caribbean. An Asia/Pacific regional network is being negotiated. The main objectives of the regional networks are the identification of improved and disease resistant germplasm and organization of training courses. INIBAP also coordinates an International Information Network on Banana and Plantain, and has strong linkages with European institutions (e.g. CIRAD, KU Leuven, Pierre et Marie Curie University, Paris) through which research on tissue culture and host-parasite relations of black sigatoka is being carried out through contractual arrangements.

Through a series of international conferences INIBAP has established the subjects and priorities for research in each of the regions, the documentation and information systems needed for Musa research, and the priorities and directions for research on sigatoka diseases. It has also established a germplasm exchange network and protocols for the safe international movement of germplasm. However, INIBAP has very little in-house research capacity. The budget for research accounts for only 20% of the total resources of INIBAP. The main function of INIBAP's research is to support and strengthen its network activities.

FHIA has a long standing dessert banana breeding programme, now funded mainly by international agencies. Other agencies have not so far had access to the expertise and advanced clonal material developed by FHIA. Plantain and cooking banana have been included in the programme relatively recently.

EMBRAPA has a relatively recent breeding programme, working primarily on dessert banana varieties of the AAB type. EMBRAPA has a black sigatoka testing agreement with CATIE.

Neither FHIA nor EMBRAPA have the facilities or the financial resources needed for strategic research on agronomic, or pest and disease problems.

CIRAD/IRFA have a long standing banana research programme which, until recently, has mostly involved export banana. Recently, a breeding programme has been established in Guadeloupe, with a cooperative exchange agreement with EMBRAPA.

Many areas of research have been identified by international meetings organized by INIBAP that are not being covered by any of the above centres. The INIBAP conferences have also identified a number of other national programmes on banana and plantain which would be relevant to a CGIAR research programme (e.g. ACIAR/New Zealand, Taiwan, Philippines).

9.4.4. Characteristics of INIBAP

TAC considered the activities and modes of operation of INIBAP to be similar to those acceptable for CGIAR centres, but noted that the in-house research capacity and the resources allocated for research were comparatively low. Some similarity with IBPGR was observed, but it was noted that IBPGR had a different type of mission. The weakness of most of the NARS with which INIBAP works, coupled with the relatively short history of strategic and applied research on these commodities mean that strong interdisciplinary research at a headquarters base is required to support and provide leadership to the network activities. INIBAP was considered to conform to the preferred institutional nature of a CGIAR centre with respect to its mandate and governance.

9.4.5. Institutional Options

TAC considered five institutional options for incorporating banana and plantain into the CGIAR. Its views as to the advantages and disadvantages of each option are summarized below:

Option 1: IITA to assume primary responsibility for banana and plantain research and establish a distinct programme. INIBAP would be given the option of becoming an integral part of IITA.

Advantages

- current research activities at IITA would provide the necessary in-house research capacity lacking in INIBAP;
- banana research within the CGIAR would be strengthened;
- INIBAP's acronym and networks could be preserved;
- it would be more cost-effective than present arrangement because it would combine in-house research and networking under one institution;

- the environment of the Onne substation of IITA is favourable for seed setting - an essential factor for the success of the breeding and genetics activities;

- regions not currently served by the CGIAR would benefit through the expanded IITA mandate and links with NARS would be strengthened;

- there would be access to other IITA skills and facilities;

- there would be close interaction with other CGIAR centres in research with a farming systems perspective.

Disadvantages

- this option is a sensitive one, since INIBAP would cease to be an autonomous institution;

- communications with collaborators in other regions would be difficult.

Option 2: **IITA to assume primary responsibility for banana and plantain with particular focus on sub-Saharan Africa.** It would maintain the base collections for banana and plantain germplasm and play a leadership role in germplasm enhancement. **CIAT and IRRI to add banana and plantain to their mandates and cater for the needs of Latin America and Asia respectively.** The relationship between IITA, CIAT and IRRI would be similar to the existing arrangements for rice research. INIBAP would have no specific role in the CGIAR.

Advantages

- most of the advantages under Option 1 would also apply;

- the centres with regional responsibilities would be closer to the NARS;

- these centres would build on their existing links with NARS;

- IRRI and CIAT are familiar with the farming systems in the regions.

Disadvantages

- this option is institutionally complex and has a potential for friction;

- the full benefit of INIBAP's achievements and skills would not be exploited within the CGIAR;

- banana and plantain research may be incompatible with the current mandates of IRRI and CIAT.

Option 3: INIBAP to have primary responsibility for banana and plantain. IITA would transfer its plantain breeding activities to INIBAP.

Advantages

- this option provides greater visibility and strong emphasis to the crop within the CGIAR;
- flexibility to locate the research base in the most appropriate country is retained;
- research and networking would be consolidated in one institution;
- current research activities on plantain at IITA would provide the in-house research capacity.

Disadvantages

- this option would be expensive and might be slow to develop because it might require new capital infrastructure if the Onne Sub-Station could not be transferred to INIBAP. It would also mean another entity added to the CGIAR;
- there is potential conflict with IITA's mandate for plantain-based farming systems research.

Option 4: Present arrangements with CGIAR funding for INIBAP through IITA and/or IBPGR. INIBAP would remain outside the CGIAR.

Advantages

- this option allows the INIBAP regional networks to operate as planned;
- INIBAP would retain its identity.

Disadvantages

- the current duplication of activities and overlapping of responsibilities would continue;
- there would be more overheads;
- funding for INIBAP would remain uncertain.

Option 5: Maintain present arrangements but incorporate INIBAP into the CGIAR.

Advantages

- this option maintains the current advantages of each centre;
- it provides an opportunity to the CGIAR to study the effectiveness of the network approach as a mode of operation.

Disadvantages

- potential duplication of effort;
- INIBAP would still not have an in-house research capacity;
- there is potential for friction with IITA.

9.4.6. Conclusions and Recommendations

Having carefully considered the institutional options outlined above, TAC decided that a modification of Option 1 was to be preferred. The TAC recommendation is that IITA should assume primary responsibility for banana and plantain research in the CGIAR and include INIBAP under the wider mandate. The identity of INIBAP should be maintained and the network component of the programme should be run from the Montpellier site for reasons of superior communications and continued fruitful contacts with CIRAD/IRFA.

TAC reached this conclusion in light of the fact that plantain is already included in the mandate of IITA, and the impressive results obtained by IITA in recent years. The programme has good supporting infrastructure such as the Onne substation, and IITA's Virology and Biotechnology Laboratories which would be essential for virus indexing. IITA like INIBAP has experience with third country quarantine for the safe movement of vegetatively propagated materials. IITA is already using banana germplasm in its sigatoka resistance breeding work. Therefore the programme could easily be expanded to include cooking banana.

9.5. Vegetables

9.5.1. Introduction

In its consideration of vegetable research, TAC was assisted by the proposal for an initiative on vegetable research it had submitted to the CGIAR in 1988, the report of a TAC sponsored review mission to AVRDC, and the recommendations of a TAC panel on vegetables. Other documentation available to TAC included the draft strategic plan of AVRDC, a proposal by AVRDC and SADCC for a collaborative vegetable research network in Southern Africa, annual reports of AVRDC and a copy of all the major publications by this centre.

TAC reiterated that vegetables were highly eligible for CGIAR support because of the rapidly growing demand for them, their importance

for human nutrition and for raising incomes of small farmers, and the fact that research on vegetables had been neglected. An international effort in vegetable research would be fully consistent with the mission and goals of the CGIAR.

9.5.2. Future Role of the CGIAR

At the request of the Group, TAC had, in 1988, prepared a proposal for CGIAR-supported research on vegetables. The proposal was in the form of a TAC commentary that amended and highlighted the report of TAC's consultant following an intensive global study, interactions with representatives from national, regional and international programmes, and a thorough exchange of views in the Committee.

TAC recommended that the Group create and support an international entity which would help establish and coordinate regional collaborative vegetable research networks in Asia, sub-Saharan Africa and Latin America. CGIAR support was to be limited initially to tomato, pepper and onion, and to leafy green vegetables. However, TAC also recommended that studies and consultations with relevant institutions be carried out to clarify the importance of other commodities such as okra and eggplant, and to determine the major constraints to production increases and marketing, as well as their researchability. The entity would then have the flexibility to phase new research topics into its programme as necessary.

TAC further recommended that the highest priority be assigned to supporting research for tropical environments, with activities for subtropical environments to be initiated once those for tropical environments had become operational.

The central emphasis of research would be on:

- evaluation and utilization of land races and cultivars at selected locations within a range of tropical and subtropical environments;
- assessment of market absorption capacity and marketing constraints, leading to the identification of suitable production areas;
- identification of researchable constraints and assessment of potential impact.

To overcome the different constraints, research might be needed in fields such as adaptive breeding for various stresses; seed physiology and seed production technology; appropriate improved technologies and cultural practices; plant protection; post-harvest physiology and technology, and socio-economic constraints.

9.5.3. Overview of Ongoing Vegetables Research

During the decades of the sixties and seventies most developing countries devoted their primary attention to research on major cereal crops, and vegetables received only limited attention. As supplies of the staple commodities became more reliable, however, there has been a

rapid increase in the capacity of national research centres to conduct vegetable research. This has been particularly true in Asia. At present there are several NARS within Asia with cadres of young, well trained research staff and with improved physical facilities for vegetable research. Although these are young programmes, the emerging capacity is substantially above that existing when TAC reviewed this aspect in the late 1970s. Several programmes are at the point where they can contribute substantially to collaborative research efforts. Latin American capacity for vegetable research has also improved substantially in the last decade, and there are a number of strong programmes. More recently, several countries in Africa have identified vegetable research as a priority area and have established units to deal with this subject. Many countries in all these regions accord the highest priority to continuing research efforts with vegetables. There are no ongoing CGIAR efforts in vegetable research. The only non-associated centre working on vegetables is AVRDC.

9.5.4. Characteristics of AVRDC

The original mandate of AVRDC was to promote the production, marketing and utilization of vegetables in the lowland tropics of Asia. Over time, the centre's mandate has become a more global one concerned with (i) improving the nutritional quality and production potential of vegetables in the humid and subhumid tropics and (ii) upgrading the quality of vegetable-related research, teaching and extension personnel in developing countries through training and dissemination of information. The major focus of AVRDC's efforts to date has been in Asia, although recently the centre has become the executive agency of a collaborative research network for Eastern and Southern Africa. AVRDC's draft strategic plan proposes that the centre take on a global role in which it would continue to serve the needs of Asia while gradually expanding collaboration with countries in sub-Saharan Africa, Latin America, West Asia and North Africa and the rest of the developing world.

In addition to research on vegetables, AVRDC also conducts research on tubers (sweet potato) and on grain legumes (soybean and mungbean). As these activities overlap with those of the CGIAR centres — CIP and IITA — the centre has proposed in its draft strategic plan that it phase out its activities on sweet potato. The external review report has also recommended that the centre transfer its work on grain legumes to national programmes.

The original choice of Taiwan as the headquarters site was made largely on technical grounds. It has both warm-wet and cool-dry growing seasons, allowing the continuous testing of varieties and practices, and the site has been particularly advantageous to AVRDC for the testing of heat-tolerance. In addition, Taiwan provided good transportation and communication facilities, proximity to a network of vegetable growers, marketing channels and research institutions, and strong support from the host government.

AVRDC's location in Taiwan has created political problems in terms of its relationship with the People's Republic of China (PRC). In recent years, the situation has improved substantially. Working relations have been established between AVRDC and PRC, following the establishment of a separate AVRDC activity at Kasetsart University, in

Thailand. As a result, there has been a flow of genetic materials from AVRDC to PRC through Thailand, and many scientists from PRC have been trained at AVRDC-Thailand.

Politically, the location of AVRDC in Taiwan remains a very sensitive issue, however. According to the review report, PRC/AVRDC interactions should continue to occur through the Thailand Centre. Modern communications techniques would make this feasible. Thailand could become the headquarters for AVRDC's operations for those countries that are concerned with the Taiwan location, if this is to be a continuing problem.

AVRDC's research has emphasized the selection and breeding of improved genetic materials, the incorporation of resistance to diseases and insects into new varieties, and crop management. If its strategic plan is endorsed by its Board, its activities will closely resemble those proposed by TAC. The centre has a record of achievements and impact particularly on tomato, chinese cabbage, sweet potato, soybean and mungbean. AVRDC intends to phase out research on chinese cabbage and sweet potato, but to develop a full-scale research programme on pepper, onion, shallot and garlic. Part of the research appears to be directed to the specific interests of Taiwan. This includes some of the mechanical harvesting trials, and several aspects of crop management research have also been directed at the advanced cropping systems of Taiwan. AVRDC's socio-economic research is non-existent at present but is expected to become an important part of the programme in the near future. The centre has very good training programmes, has been effective in information collection and exchange, and has contributed substantially to building in national systems.

AVRDC has been granted international status by its host government and by various other national governments. The centre's mandate is similar to that of a CGIAR centre. Its organizational structure is rational, and the centre's resources have been well managed. The structure and composition of AVRDC's Board of Trustees differs from that of the CGIAR centres in the extent of donor representation, and the lack of TOR for Board membership. Currently the Board includes a majority of members representing donors, i.e. five "countries" and two "agencies". Five individuals are elected in their individual capacity. The rapid rise in operational costs in Taiwan, particularly in labour costs, has led to a situation in which 75% of AVRDC's costs consist of salary expenditures. As Taiwan's economy further transforms into that of a developed country, this may affect its operations over the medium term.

9.5.5. Institutional Options

TAC considered three options with respect to a CGIAR initiative in vegetable research:

Option 1: Admit a modified AVRDC into the CGIAR.

Option 2: Create a new entity - an International Service for Vegetables Research (ISRV) - with a headquarters location in Southeast Asia.

This option would be a modification of the basic proposal formulated by TAC in 1988. The Service would act as a coordinating body for collaborative research with national programmes through networks and the contracting of research and research-related activities. In contrast to the original proposal, the ISVR would have an in-house research capacity. AVRDC would remain outside the CGIAR but play a substantial role as a member of the network, with leading responsibilities through contracts for research on tomato and pepper, for medium- and long-term germplasm storage, information services and training.

Option 3: Incorporate the responsibility for coordinating global efforts in vegetable research into the mandate of an existing CGIAR centre.

This centre could act as a focal point for regional collaborative network activities. In this option, AVRDC as an entity would remain outside the CGIAR but would closely collaborate with the coordinating centre and the networks.

9.5.6. Conclusions and Recommendations

After careful consideration of the different institutional options, TAC recommended the first option, to incorporate AVRDC into the CGIAR, subject to the set of conditions as presented below. This recommendation was made in the belief that it would be desirable to use available facilities and expertise and to avoid the creation of a new entity if a reconstituted AVRDC could serve the global needs. TAC has not been influenced by political considerations in making this recommendation. It is based solely on technical and programmatic grounds.

In order for AVRDC to qualify for CGIAR support it would have to fulfil the following conditions:

- that the Board of AVRDC formally endorse those portions of the draft strategic plan which position AVRDC as a centre with a global mandate for vegetable research throughout the developing world;

- that AVRDC implement collaborative vegetable research networks in sub-Saharan Africa and Latin America, allocating sufficient resources (financial and human) to those activities to respond to the research needs of those regions and strengthen their national research systems;

- that AVRDC phase out responsibilities for grain legumes (soybean and mungbean) to collaborative national programmes, for sweet potato to CIP, and that it give greater attention to research on green leafy vegetables;

- that AVRDC phase out a major part of its activities targeted only towards the needs of the host country;

- that AVRDC allocate a substantially higher share of its research resources to its operations in Thailand so as to cover a wider

range of tropical environments, including any further capital investments in new infrastructure;

- that AVRDC maximize the use of available research facilities of its collaborative partners in Thailand and elsewhere, and avoid duplication at its headquarters;

- that AVRDC change its name to the International Vegetable Research Institute, to reflect its global mandate;

- that AVRDC adjust its Board composition and selection process in line with the norms prevailing in other centres, and thereby reflect its global concern with vegetable research.

If AVRDC is not in a position to comply with the recommendation, or if it would involve a long delay in starting the CGIAR initiative, TAC recommends the second option, which is based on the proposal it formulated in 1988. TAC rejected the third option because it was unlikely that vegetable research needs could be adequately met by an existing CGIAR centre.

9.6. Fisheries

9.6.1. Introduction

In its consideration of research on fisheries, TAC was assisted by the report of a TAC Fact-Finding Mission to ICLARM, of TAC's ad hoc Working Group on Aquaculture, the desk analysis prepared by the TAC Secretariat, and the recommendations of the TAC panel on Fisheries. Other documentation available to TAC included reports from Dr. Idyll to TAC on a CGIAR initiative in aquaculture research, draft reports prepared for the Study on International Fisheries Research, a recent FAO study on Developments in Aquaculture, the medium-term plan of ICLARM as well as annual reports and other major publications from ICLARM.

TAC considered that fisheries comprised the whole continuum of production systems, from capture fisheries to intensive aquaculture. It concluded that fisheries were eligible for CGIAR support because of the importance of fisheries in developing countries and because there was a need for strategic research on fisheries. CGIAR support should be limited, however, to research on fisheries in inland and coastal areas, rather than on deep sea or ocean capture fisheries. TAC also concluded that capital intensive aquaculture did not warrant CGIAR support.

9.6.2. Future Role of the CGIAR

TAC's deliberations on a possible CGIAR initiative in fisheries research began as early as its second meeting in October 1971 and continued in 1976, 1978 and 1979. The discussions received new momentum in 1985 when, in its review of CGIAR priorities and strategies, TAC identified aquaculture as an area of high priority for CGIAR support.

Following the approval of TAC's recommendations by the CGIAR, a number of reports have been prepared on the focus of such an international research initiative, and how it might be implemented.

Between the extremes of capture and culture fisheries, from simple artisanal fisheries to intensive aquaculture, lies a continuum of fish production systems which can be interrelated, depending on the degree of control or management of the fish 1/ or of the production environment involved. All these systems pose a number of common scientific problems, e.g., the need for knowledge of the population dynamics of early life stages, or the need for improved nutrition. At the same time it has to be recognized that the assimilation of new scientific knowledge is itself a gradual process, dependent on the social and economic circumstances of the community to which it is available. Further scientific advances in fish production now require both an ability to reformulate strategic scientific questions and to develop a multi-disciplinary approach that integrates the contributions of experts in areas such as genetics, nutrition and pathology.

In defining research priorities the following considerations are important:

- As the system of fish exploitation becomes more intense, strategic research in ecology, genetics, nutrition, pathology and reproductive biology becomes necessary. The applications of knowledge derived from strategic biological research are likely to be of most importance in semi-intensive systems. Of particular significance is increased understanding of ways to improve pond productivity, the role of supplementary feeding and the integration of pond culture into existing farming systems, particularly in Asia.

- Research to analyze and understand the social and economic factors which condition the take-up (and take-off) of new technology is essential.

- Open bodies of water offer potential for increased fish production through stock enhancement of selected species. To realize this potential, substantial scientific investigations are necessary on the production of fry, effective enhancement of population recruitment, proper use rights and accessibility of the exploited stocks. Work of this kind could be of great benefit to many small rural communities, and production in such open systems is non-demanding of artificial diets and may be environmentally sound.

- Sustained exploitation of open (coastal) fisheries can only be attained if good basic information on stocks is available. Stock characterization is, however, poorly developed for many species and this problem needs to be addressed, particularly as in many cases what was thought to be a simple stock is revealed as a complex of several or many stocks. Development of methods for systematic study of stocks of important species using modern techniques is therefore needed. This also has obvious implications for the conservation of germplasm.

1/ Fish: Generally include all aquatic organisms, whether plant or animal (finfish, shell, shrimp, molluscs, algae, and so on).

- In all fisheries systems, optimization of management regimes requires a capacity to model life histories, environments and production systems. Appropriate knowledge of these with respect to the fish species of tropical and subtropical regions is very sparse, and research designed to develop a capacity to carry out modelling is needed.

- CGIAR support should be limited to research on fisheries in inland and coastal areas. The CGIAR should not undertake research on deep sea or ocean capture fisheries, or on intensive high input aquaculture, because such research would be outside the mission and goals of the CGIAR.

9.6.3. Overview of Ongoing Fisheries Research

None of the CGIAR centres has research activities in the field of fisheries or aquaculture, although through the Asian Rice Farming Systems Network IRRI has done some collaborative research with the International Centre for Living Aquatic Resources Management (ICLARM), the only non-associated centre with activities in this field. FAO is the most important organization involved in fisheries, but its activities are mainly in the development spectrum. ICLARM collaborates with FAO, mainly in the area of information. There appears to be a certain overlap of activities in information dissemination between ICLARM and FAO.

The Southeast Asian Fisheries Development Centre (SEAFDEC) is a regional intergovernmental fisheries development organization based in Bangkok, Thailand. Its Department of Aquaculture is at Iloilo, the Philippines. It was established in 1967 and its member nations are the Philippines, Japan, Thailand, Malaysia and Singapore. SEAFDEC has an aquaculture programme with a mandate to undertake research and provide training for the development of appropriate technologies for tapping Southeast Asia's vast potential for aquaculture. SEAFDEC also has a Marine Fisheries Research Department in Singapore and a Marine Fisheries Training Department in Bangkok, Thailand. The Centre's first priority is training, and its research is usually conducted in support of training. Although SEAFDEC has good research facilities, they have recently suffered from a lack of maintenance. Although SEAFDEC's research interests in aquaculture are similar to those of ICLARM, there has been regular interaction but little collaboration between the two institutes.

The Network of Aquaculture Centres in Asia (NACA) grew out of a UNDP/FAO regional project and is, since January 1990, an inter-governmental body established by 13 participating governments of Asia and the Pacific region to assist them in expanding aquaculture for increased production of living aquatic resources (specifically fish and shellfish) to improve rural welfare, diversify rural farm production and increase foreign exchange earnings. NACA seeks to achieve its objectives through programmes implemented by a network of regional lead centres in China, India, the Philippines and Thailand that are closely linked to a number of national centres in the participatory countries.

NACA's activities focus on training, applied research and information collection and dissemination. It is not involved in long-run strategic research, but focuses primarily on the transfer of technology: ICLARM and NACA cooperate through joint meetings,

conferences and publications, but relations are not as productive as they might be given the complementary nature of their mandates, priorities and strategies. NACA does not appear to be in a position to take on regional leadership in aquaculture.

The Asian Institute of Technology (AIT) is an independent international and non-profit making educational and technological institution. AIT has aquaculture as one of five fields of study within the division of agricultural and food engineering. The majority of aquaculture staff are seconded to AIT from the United Kingdom. The AIT aquaculture department has research programmes associated with its graduate research activities. The main emphasis of the research is on low-cost semi-intensive aquaculture systems appropriate to the limited resource base of small scale farmers, and on the production of herbivorous fish. AIT has extensive research facilities.

TAC carefully considered activities and strengths of national research programmes on fisheries. In general, national programmes are severely constrained by the fact that fisheries departments come under the Ministry of Agriculture, and that they have a severe shortage of qualified staff and operating funds. India has a strong national programme with good capabilities in genetics. Thailand, Indonesia and Malaysia have good facilities but are constrained through lack of operational funds and their links with the Ministry of Agriculture. In Asia, all fisheries research departments give high priority to aquaculture.

ICLARM has been highly dependent on collaboration with a number of national programmes as a means of carrying out its research since it has few facilities of its own. It has also built strong ties with individual scientists through its own networks and support to the Asian Fisheries Society. With the exception of the Coastal Area Management Program, ICLARM's networks involve scientists rather than institutions.

ICLARM has also collaborated with other types of institutions, particularly the Asian Institute of Technology and the Collaborative Research Support Programmes (CRSPs) of USAID and BIFAD, the Fisheries Stock Assessment CRSP and the Pond Dynamics/Aquaculture CRSP.

9.6.4. Characteristics of ICLARM

ICLARM was established along the lines of a CGIAR centre to conduct, stimulate and strengthen fisheries and aquaculture research in Asia and the Pacific Islands. More recently, it has extended its work to Africa (aquaculture) and to Latin America (stock assessment/ management). ICLARM's major role is to conduct and promote research. In 1989, research comprised 37% of total operating expenditures, a level below the norm in the CGIAR. TAC assumed that this was a temporary situation which is due to the lack of core resources and ICLARM's dependence on restricted funds. This opportunistic approach, which has led to a large share of the centre's activities being technical-assistance oriented, should be carefully assessed as the centre develops a strategic plan. ICLARM's research is mostly strategic and applied in nature and is carried out in association with national programmes.

ICLARM meets only part of the needs for international research on fisheries. In fishery resource evaluation and coastal management,

ICLARM's activities concentrate largely on the refinement and application of existing approaches and models. ICLARM has not developed original programmes of a strategic nature aimed at developing methodological tools in response to newly emerging issues, e.g. the modelling of coastal hydrodynamics, population dynamics of early life stages, etc. This was inevitable, because funding imperatives forced ICLARM's programmes more towards applied research in support of development programmes, rather than towards strategic research. ICLARM's coastal area management work is centered largely around economic planning rather than research on modelling alternative coastal land/water uses. Aquaculture research of ICLARM globally is at the stage of information collection and problem identification, though it is recognized as a major area for achieving sectoral goals; further, little research of a strategic nature has been done on aquaculture.

TAC concluded that most of the activities of ICLARM conform to those considered acceptable for a CGIAR centre. ICLARM is a research institution, with a number of activities that relate to TAC's list of international research and related needs. ICLARM's mode of operation closely follows that of a CGIAR centre, especially in its Capture Fisheries Management, Aquaculture and Information programmes. The Coastal Area Management Programme conforms less to the CGIAR model, because in addition to applied research it involves considerable technical assistance and project management. However, this programme does represent an international research need: "Land use management research to understand multiple and competing land use options for coastal areas". TAC concluded that research in this area is needed, but ICLARM's present involvement was less related to research than to technical assistance. In its work in capture fisheries management and aquaculture, the centre operates through collaborative research, having no research facilities of its own at headquarters or in its host country.

ICLARM has been heavily involved in developing national research capacity. To do this it has emphasized training, which is complemented and strengthened by a strong programme in documentation and information. The Centre has made considerable investments in developing and coordinating networks, most of which have information exchange as their major purpose. The Coastal Aquaculture Network is involved in both research consultation and collaborative research, while the Giant Clam Research Group is a collaborative research network. The ASEAN Coastal Resources Management Project acts mostly as a collaborative research and information exchange network. The ASEAN Fisheries Social Science Research Network is a research consultation network. ICLARM has emphasized close working relationships with national programmes, through outposting of staff, and through training and networking.

ICLARM's programme is, by and large, international in scope and content. It also reflects the interests and needs of some developing countries through the planning mechanisms of the networks it coordinates.

TAC concluded that both the mandate and the governance of ICLARM conform to that of the CGIAR Centres.

9.6.5. Institutional Options

TAC considered the following options for CGIAR support to selected aspects of fisheries research:

Option 1: Admit a modified ICLARM into the CGIAR System.

Option 2: Incorporate ICLARM into an existing CGIAR centre or another non-associated centre.

9.6.6. Conclusions and Recommendations

In TAC's view, selected aspects of inland and coastal fisheries research qualify for CGIAR support by virtue of the importance of fisheries in human nutrition and for contribution to employment and income generation to many small rural communities.

Research activities in fisheries are not adequately represented in other international research centres. The continuum of fisheries systems requires more strategic research of an international character. ICLARM is already conducting research on most of the needs identified in Chapter 4.

In addition, there are a number of areas that need attention from an institute like ICLARM. Unmet or partially met needs include pond productivity and nutrient dynamics, especially in semi-intensive systems, development of alternative feedstuffs (especially replacing use of fishmeal supplements), reduction of disease transmission through seed distribution, understanding of gender issues in fisheries, and methodologies for creating fish production systems in which local people are able to participate fully.

Some of the resources needed to enhance strategic international research on the enlarged research agenda mentioned above can be found by reducing some of ICLARM's information and training activities which are also carried out by regional organizations.

In the light of the above, TAC concluded that the second option was not appropriate. It is unlikely that incorporation of ICLARM into an existing CGIAR centre, e.g. IRRI, would be beneficial to either party and might well be inhibiting. There is no obvious candidate non-associated centre with which ICLARM might be combined.

ICLARM could be the entity to achieve the CGIAR fisheries research objective, provided certain conditions are fulfilled by its Board and management. If the CGIAR decides in principle to support fisheries research, ICLARM should be asked to develop a draft strategic plan and make it available before a comprehensive EPR/EMR is carried out. Also, to meet its goals the centre will need research facilities of its own at its headquarters, rather than borrowing facilities as at present. Furthermore, it will also be necessary for ICLARM to set up a Scientific Advisory Committee, with a high proportion of active fisheries research workers.

Along with a decision to include ICLARM in the CGIAR System, it is important to consider the global need to strengthen the strategic

research capabilities of developing countries in fisheries. These are inadequate at present. This gap is likely to be particularly detrimental in the future, since new management needs and development opportunities have emerged as a result of resource scarcity in fisheries. Although these scientific issues are of global concern, their relative importance differs among geographical areas, depending on the present and potential significance of fishery systems. In this respect, the development of regional structures for cooperation in research, and of new areas of strategic research, require different institutional arrangements at national and regional levels.

ICLARM could assist or lead in regional or continental efforts to stimulate and conduct strategic research on priority matters, probably through a network mode of operation.

If ICLARM is brought into the CGIAR System, it could also stimulate work in those areas of fisheries not covered by its current research agenda but suggested as international research needs. These include understanding human health hazards in fishing systems, and the development of fish processing/preservation techniques. A topic of much wider scope that may have an impact on fisheries, but that is outside the specific mandate of ICLARM, is the effect of global environmental changes on fisheries. ICLARM could also give further consideration to developing cooperative research with IFPRI on fisheries policy and with ISNAR on fisheries research management.

9.7. Livestock Diseases in sub-Saharan Africa

9.7.1. Introduction

There is a widely held view that livestock productivity research is important in all developing regions of the world (Chapter 3, Sections 3.3.3.2., 3.4.3.2, 3.5.3.2., and Table 4.3.). To place the matter in perspective, a comprehensive study of livestock production and related research needs has been suggested. However, this would take much longer than the time available to TAC to make its recommendations to the CGIAR on the possible inclusion of the International Centre of Insect Physiology and Ecology (ICIPE) and the International Trypanotolerance Centre (ITC) into the CGIAR System.

In carrying out this task, TAC mounted Fact-Finding Missions to these centres, and was further assisted by desk analyses prepared by the TAC Secretariat, which inter alia included a review of various documents on CGIAR livestock research in sub-Saharan Africa. TAC also had at its disposal the report of the TAC Panel on Livestock Diseases in sub-Saharan Africa. The analysis and assessment of the subject matter covered by ICIPE and ITC was limited to research on ruminant diseases in sub-Saharan Africa. Although the Centre de Recherches sur les Trypanosomes Animales (CRTA) was not on the list of institutions suggested to TAC for review, its work on the West African Shorthorn (Baoulé) is similar to the activities of ITC on the N'Dama. Therefore TAC decided to include it in the study.

9.7.2. Animal Health and Productivity

Most of the major infectious livestock diseases can now be controlled through modern technology. Although many of these diseases

still exist and reduce the productivity of livestock in Africa, better control depends on improved delivery systems rather than on additional strategic research. There are, however, numerous other diseases which cause serious losses in livestock production, particularly in Africa, for which international strategic research is currently either lacking or inadequate.

Several approaches have been used in the literature to group important animal diseases. One such grouping, suggested by the TAC Panel on Livestock Diseases in sub-Saharan Africa, is according to the epidemiological features of the disease, expression of a disease being a consequence of the interaction between the nature of the pathogen and the livestock production system involved:

Group 1: Epidemic diseases which are relatively independent of production system and environment, have a wide distribution and thus constitute an international or regional risk and cause moderate to severe disruption of production through mortality and/or depressed productivity (e.g. rinderpest, contageous bovine pleuropneumonia, foot-and-mouth disease).

Group 2: Parasitic diseases, mainly vector transmitted, that have a wide geographic distribution, are land-use (and consequently environment) and production system dependent, and cause mortality and depressed productivity (e.g. trypanosomiasis, tick-borne diseases and endo-parasitic diseases).

Group 3: Endemic (viral, bacterial or protozoal) and production diseases which significantly depress animal productivity but in an insidious, less obvious way. Low reproductive performance and reproductive diseases belong to this group, in which diseases are frequently associated with nutritional and management practices and environmental characteristics.

9.7.3. Future Role of the CGIAR

TAC used the grouping of diseases described above to help identify critical areas which could benefit from international strategic research. On the basis of the information available to TAC and the recommendations of the TAC Panel on Livestock Diseases in sub-Saharan Africa, it was concluded that research on diseases in groups 2 and 3 would be appropriate for CGIAR support. This conclusion reflected the considerable attention already given by public and private organisations outside the CGIAR to group 1 diseases. The CGIAR has no special advantage in conducting research on this group of diseases. Research on epidemiology and the socio-economics of animal diseases in general was also considered to deserve greater attention within the CGIAR. Further research needs and priorities in sub-Saharan Africa potentially eligible for CGIAR support should emerge from the long-term studies discussed in Section 9.7.6.

9.7.4. Overview of Ongoing Livestock Diseases Research

The work in progress on trypanosomiasis involves research on the vector - the tsetse fly, (ICIPE, ITC); on the parasite - various species of trypanosomes (ILRAD) - and on the hosts, as well as on the

interactions between the vector, the parasite and the host (ILRAD, ITC, CRTA and ILCA). Among the CGIAR centres, ILCA co-ordinates the work on trypanotolerance through its Trypanotolerance Research Thrust. ICIPE is conducting research on the biology and ecology of tsetse and on limited aspects of control. Research on the more applied aspects of tsetse ecology related directly to control, and on control methodology, is being carried out by ITC and CRTA. Research on the basic biology of trypanosomes, directed towards the control of trypanosomiasis through the use of vaccines, diagnostics and chemotherapy, is conducted by ILRAD. ILRAD is the lead centre in the world in the application of basic knowledge about trypanosome and molecular biology to the problems of animal trypanosomiasis. ILRAD backstops much of the global effort in research on animal trypanosomiasis by providing specific reagents, parasites and other materials and support. CRTA is engaged in a cooperative study on resistance to trypanocidal drugs with ILRAD.

Studies on the pathology of trypanosomiasis in animals, bovine immunology, immuno-genetics, trypanotolerance mechanisms and genetic markers essential to control are being conducted by ILRAD. CRTA is engaged in research on immuno-genetics and trypanotolerant breed characterization, while the ILCA/ILRAD Trypanotolerance Network is developing strategies for the use of genetic markers for breeding trypanotolerant cattle.

CRTA and ITC are engaged in long-term strategies to improve the productivity of the Baoulé and N'Dama breeds, respectively, and to provide foundation genetic stocks (animals, embryos and semen) for use in the tsetse-infested areas of West and Central Africa. The work of ITC and CRTA provides unique opportunities for applied research on trypanosomiasis control through trypanotolerance and for the field testing of production and disease-control strategies. These opportunities are not currently available to ILCA or ILRAD.

ILRAD is working on the parasite responsible for theileriosis while ICIPE is working on the vector. The work by ICIPE on the vector is unique, in that it is the only concerted international research effort that focuses on vector control strategies. However, a number of laboratories in developed countries are also working on the vector.

The review of the work in progress on trypanosomiasis, theileriosis and their vectors was intended to enable TAC to decide on the possible role for ITC and ICIPE in an expanded CGIAR. Particular attention was given to:

- the need to promote and coordinate international research on trypanosomiasis and theileriosis;
- the identification of additional research areas that need international support;
- enhancing CGIAR efforts in strategic research while at the same time promoting the development of adequate research and development channels for the transfer of technology.

9.7.5. Characteristics of ICIPE, CRTA and ITC

The activities and modes of operation of ITC are constrained by the fact that the centre works through a set of independent projects

over which it has very little control. The centre plays a dual role: international research on trypanotolerance, mainly through the ILCA/ILRAD Trypanotolerance Network, and executing the National Livestock Development Project of The Gambia. The governance and structure of ITC are very similar to those of the CGIAR centres.

The activities and modes of operation of ICIPE and CRTA are considered to be basically in conformity with those of centres in the CGIAR System. ICIPE's governance and structure are also very similar to that of CGIAR centres. However, CRTA does not have an independent governing body.

9.7.6. Conclusions and Recommendations

TAC considers research on diseases in groups 2 and 3, including research on epidemiology and the socio-economics of animal diseases, to be appropriate candidates for future CGIAR support. The overview of livestock research needs in developing countries (Chapters 3 and 4) and the analysis of current research activities on ruminant livestock diseases in the CGIAR and the NACs suggested a need for strategic research in all developing regions.

However, to go beyond these general conclusions was not possible in the time available. TAC's analysis had to focus on ITC and some aspects of ICIPE but rational long-term recommendations require a much more comprehensive analysis of international research priorities for disease- related work in the broader context of CGIAR efforts in livestock research in general. TAC is mid-way in a comprehensive priority and strategy exercise which will be available in September 1991. Further, a comprehensive assessment of the role of animals in agricultural development has been initiated by Winrock International. TAC is a participant, along with other agencies, in supporting that study. The Winrock analysis is focusing first on sub-Saharan Africa with the expectation that the Africa component will be completed by June 1991. The fact that these two major studies are in process led TAC to conclude that making long-term recommendations regarding ITC and the animal disease vector work of ICIPE is premature. Therefore only interim recommendations are made. TAC will revisit the entire subject after the completion of the studies and in conjunction with the external reviews of ILCA and ILRAD in 1991-92.

TAC noted that there are many institutions in developed and developing countries pursuing research on ticks and tick-borne diseases. Thus, a careful evaluation of the tick work of ICIPE can only be done in a much more detailed and broader context. In the interim it is TAC's judgement that decisions on the livestock disease vector work of ICIPE should be deferred until these broader studies have been completed.

There is already much ongoing work in the CGIAR on various aspects of trypanosomiasis at both ILRAD and ILCA. Of particular relevance is the Trypanotolerance Network operated by ILCA of which ILRAD and ITC are members. It is TAC's judgement that any comprehensive livestock productivity and disease research programme for Africa will contain attention to a better understanding of trypanotolerant breeds.

Therefore, so that ITC's promising research work is sustained during the period of completion of the long-term studies, TAC recommends

that the research components of ITC's program which contribute to the trypanotolerance network be provided donor support through the network until such time as the CGIAR long-term livestock strategy is completed.

TAC further recommends that in the interim ILCA, ILRAD, ITC, CRTA and ICIPE form a high-level working group to: (i) assure maintenance of ongoing trypanotolerance work of importance; (ii) develop a longer-term research strategy for an integrated disease and productivity programme in trypanosomiasis; and (iii) to explore possible institutional mechanism for a coordinated programme. Further, TAC feels that better coordination between ILRAD and ILCA in strategic planning would help focus the CGIAR in current efforts in livestock in Africa.

Finally, TAC notes that when it revisits the question of the CGIAR activities in livestock, especially in Africa, it will explicitly examine the potential roles of CRTA and ICIPE as well as those of ILCA, ILRAD and ITC.

9.8. Coconut

9.8.1. Introduction

The coconut palm is a pan-tropical crop, grown on approximately 11.6 million ha in 82 countries. Many of the producing countries are small islands in the Pacific, Caribbean and Indian Oceans. Coconut is both their primary subsistence crop and their only significant source of export earnings. There are few, if any, alternative crops which can substitute for coconut in these countries. In many island countries it provides 50% or more of total export earnings.

Coconut is predominantly a smallholder crop, with at least 96% of total world production coming from smallholdings. About 70% of the total crop is consumed in the producing countries. The crop can be grown in harsh environments, such as atolls, high salinity, drought, or poor soils. It plays an important role in the sustainability of often fragile ecosystems in island and coastal communities. Coconut is used as a source of food, drink, fuel, stock feed and shelter for village commmunities. It is also a cash crop, able to be used to produce many items for sale, at either the local, national, or international level. The main internationally traded products are copra, coconut oil, copra meal, and desiccated coconut.

The 1985 TAC review of CGIAR Priorities and Strategies identified coconuts as a priority commodity for international support. Subsequently the CGIAR requested TAC to explore the desirability of establishing an international research initiative on coconut, and the form such an initiative might take. TAC then considered the current status and future trends for coconut within the context of the world fats and oils markets; the importance of coconut as a subsistence crop, as a cash crop, and as a component of long-term farming systems; current research programmes; future needs for coconut and opportunities for further research; possible options for an international research initiative; and possible institutional mechanisms by which such an initiative might be implemented.

A detailed review of vegetable oil research needs and priorities can be found in three consultant's reports prepared for TAC and

discussed at its 46th, 50th and 52nd meetings 1/. On the basis of these reports and the TAC deliberations, a proposal was prepared, the "Role of the CGIAR in Coconut Research" which summarizes the salient points.

9.8.2. Relative Priority of Coconut

Coconut is a major crop in Papua New Guinea and the Pacific Islands, the Philippines, Indonesia and South Asia. It is locally important in coastal regions throughout the remainder of Asia, in West and East Africa, Mexico, Central America and the Caribbean Islands. In addition to the value of coconut production for domestic use and export earnings in those areas, there are other reasons why coconut would be appropriate for CGIAR support. These include its significant contribution to agricultural GDP and foreign exchange earnings of many small, mostly island countries; the important role coconut plays in intercropping systems, sustainability of coastal lands and islands; and the central role coconut plays in village life by providing many items for food, shelter and clothing.

9.8.3. Future Needs and Opportunities for Coconut

There are four major constraints to increased coconut production in developing countries: the low productivity of many coconut trees due to their age and poor nutrition; the failure of many replanting programmes designed to replace old trees which are beyond their productive life span (about 60 years); the fluctuating productivity due to variable environmental conditions; and the inefficient handling and processing, with a low farm-gate price to smallholders. The needs are to increase the productivity of the crop by the use of locally adapted high-yielding, pest and disease tolerant varieties in any replanting or new planting schemes; to increase the productivity of existing plantations by encouraging better agronomic practices, including the control of diseases, insects and weeds, the use of fertilizers, and the identification of profitable and sustainable intercropping systems; to develop improved methods of handling and processing coconut; and to diversify the coconut products traded and actively promote new products in the marketplace, so as to utilize fully the potential of the crop. The opportunities arise from the increasing demand for oils and fats and animal feed sources, particularly in developing countries as incomes rise, and the ability of the coconut tree to produce a wide variety of useful products.

9.8.4. Rationale for Further Research

The increasing importance of coconut to meet the growing demand for vegetable oils and fats in producing countries; the continuing premium prices paid for the lauric acid oils (coconut and palm kernel oil), primarily for their industrial uses in soaps and detergents; and declining competitiveness of coconut, provide the rationale for

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1/ Coconut Research: An International Initiative (June 1988)
Coconut: International Research Priorities (September 1989)
Coconut Research Opportunities (June 1990)

increased research effort. Research is required to make coconut more competitive by increasing its productivity in a manner analogous to what has occurred with oilpalm. Virtually all the benefits of coconut research will accrue to developing country producers and consumers.

Coconut is the major tree-crop component in several agroforestry systems throughout the world. Its wide use in home gardens is probably not reflected in official statistics for area under cultivation, volume of production and total value of production. Research should aim at developing technologies to stabilize production and thus contribute to regular income levels for coconut producers, and the reduction of poverty.

9.8.5. Future Role of the CGIAR

Coconut breeding in several countries over the past 30 years has demonstrated that hybrids are capable of yielding up to 6 tons copra/ha/year, under favourable conditions (cf. world average yield of 500 kg/ha/year). Progress has also been made in the identification of the causal agents of diseases of previously unknown etiology, such as cadang-cadang disease in the Philippines and lethal yellowing disease in the Caribbean. Nutritional studies have shown that coconut responds to fertilizer application, particularly potassium and chloride. Intercropping and the use of cattle under trees has shown that the total productivity of the coconut lands can be improved, while still maintaining the long-term sustainability of the system.

These results suggest that a well-organized and adequately funded international research effort could yield high returns on the investments. The long-term nature of coconut research, the history of discontinuity and lack of support in its funding, the prospects of high returns from research investments, and the likely benefits to smallholder producers, make coconut a particularly suitable target for an international research initiative. The priority research areas that warrant an international effort are: germplasm improvement (collection, conservation, breeding and evaluation); disease and pest control; sustainability of coconut-based farming systems; post-harvest handling and utilization; and socio-economics.

9.8.6. Overview of Ongoing Coconut Research

There are several national research programmes in each of the coconut-growing regions of the world. In Asia, there are programmes in the Philippines (Philippines Coconut Authority and several universities), Indonesia, India, Sri Lanka, Malaysia, Thailand, China and Vietnam. In Oceania, there are several small but active programmes, including those in Papua New Guinea (Cocoa and Coconut Research Institute), Solomon Islands, Vanuatu, Fiji and Western Samoa.

In Latin America, the main research programmes are in Brazil, Jamaica, Trinidad, and Mexico. Currently, there is no breeding programme in Latin America, despite the existence of lethal coconut diseases in that region. There is a germplasm collection in Jamaica, established when a major international effort was made on lethal yellowing disease.

In Africa, the major programme is in Côte d'Ivoire, at the Marc Delorme Coconut Research Centre established in 1951. It is the world's major coconut breeding institute and is managed by the French Institut de Recherches pour les Huile et Oleagineux (IRHO), on behalf of the Government of Côte d'Ivoire. There is also an active programme in Tanzania, and several smaller programmes elsewhere in Africa.

The only coconut research programme which operates in several countries is that of IRHO. This institute also manages a small station in Vanuatu, as well as laboratories in France. In addition, IRHO has staff stationed with national programmes in several countries, including the Philippines, Indonesia, Brazil, and Fiji. Its research has been concerned primarily with addressing the needs of replanting programmes, particularly by the production and evaluation of new hybrids, and establishing their nutritional requirements. IRHO's best available hybrid has a yield potential of 6 tons copra/ha.

Several industrialized countries have laboratory-based research on coconut in both the private and the public sector. The major efforts have been in Europe on tissue culture (UK and France), and on post-harvest technology (UK). The EC has recently established a small Secretariat in Paris (BUROTROP) to coordinate European support for research on coconut and palm oil, and to improve the linkages between such research and bilaterally funded development projects in producing countries. This European initiative on oil crops research is complementary to any CGIAR initiative in coconut research, and should facilitate participation by scientists and research institutes in Europe in collaborative, international research on coconut. The priority area established by BUROTROP in its first year is oil palm in Africa.

ACIAR is sponsoring collaborative research on coconut improvement between Australian scientists and coconut researchers in Oceania and the Philippines. The main areas covered are germplasm collection and exchange, tissue culture and virus/viroid diseases (cadang-cadang and foliar decay disease).

IBPGR has supported several germplasm collections of coconut. It has also commissioned research on coconut embryo culture and in vitro crop preservation. FAO and UNDP have supported several coconut research and development projects for national programmes. Bilateral donors support a range of individual projects.

The dearth of strong national coconut research programmes has serious implications, given that it is the stated policy of many governments to increase coconut production by rehabilitating and/or replanting existing areas and planting new land. Implementing this policy will require substantial, long-term financial support.

The major problems with current research efforts are that, with few exceptions, national coconut research programmes are seriously understaffed and underfunded. Even in the major producing countries of Asia, the national programmes are not supported in a manner commensurate with the economic importance of the crop.

There are, however, several national programmes which could contribute greatly to any international initiative on coconut research, if adequately funded. The Marc Delorme Research Centre in Côte d'Ivoire has a substantial germplasm collection and a number of promising

hybrids, the result of some 30 years of research. Any international initiative needs to find a way to build on the substantial financial and scientific investment in this station to enable it to continue to contribute to coconut research internationally.

The key problems with the current research effort are that most of the national programmes are not well supported financially, either by government or by the industry. They lack continuity of funding from both national and external sources; they lack a critical mass of appropriately trained staff and suitable facilities; they are not addressing adequately the major problems facing the crop; they are not producing sufficient substantive results directly relevant to smallholders; nowhere are the needs of the crop worldwide being addressed; and there are presently no means by which small producing countries, which are unable to mount their own research effort, are able to gain access to new technologies, including higher yielding varieties.

9.8.7. Institutional Options

Although there are many bilaterally and multilaterally funded coconut research and development projects, all currently operate for relatively short periods (usually 3 to 5 years), and are rarely linked to one another. The discontinuity of funding is not conducive to a sustained increase in coconut productivity. If an increase in the productivity of coconut is to be achieved, a critical mass of funds and research capacity over a sustained period will be needed.

TAC considered several institutional mechanisms by which an international research programme on coconut could be established. The options included mechanisms which could be incorporated into the CGIAR System. On the basis of the analysis, TAC selected the three options outlined below:

Option 1: Establish an International Coconut Research Council, to identify, support, promote and undertake research of international significance.

The council would be able to undertake research itself; contract research to national programmes and to other advanced laboratories elsewhere; establish subject-specific research networks on problems of international significance, establish regional networks; and manage a multi-site germplasm collection.

Advantages

The advantages of this option are that it provides a focus for research, training, and documentation on coconut. It assembles a critical mass of scientists and resources under effective management. It provides a mechanism for continuity of funding, and allows a global view of research needs. This option guarantees the free availability of research results and improved germplasm for use by large and small countries. It builds on and strengthens existing research capacity by providing additional funds to enable some national programmes to undertake research of relevance to many countries. It allows an in-house research capacity to be developed, but requires limited

in-house research facilities and still permits a decentralised approach. It provides financial support for existing germplasm collections and breeding programmes of international significance. Collaborative research amongst scientists in different countries would be facilitated as would participation by both public and private sector organizations. Lastly it allows participation by small countries with no national research programmes in an international coconut breeding and evaluation programme.

Disadvantages

This option would incur a higher cost, especially during the establishment phase. In addition, research leadership and management would be more difficult than with a commodity centre at one location. With this option, it would be more difficult to avoid a "top-down" perception by national programmes. Obtaining international legal status might be a lengthy process, and the end result might give too high a priority to coconut relative to other commodities within the CGIAR System.

Option 2: International Rice Research Institute - Coconut Research Unit

The major coconut producing and exporting country is the Philippines. The International Rice Research Institute (IRRI) in the Philippines could host an international coconut research network, and provide logistical support for its activities in Asia/Pacific, Africa, Latin America and the Caribbean.

Advantages

This option establishes a critical mass of expertise and resources focused on coconut research. It retains flexibility in the modes of operation but allows an in-house research capacity and contract research responsibilities at the same time as regional and subject-specific networks. It also enables research to be contracted to NARS and other advanced laboratories. It allows global coverage of activities and provides international auspices for a multi-site germplasm collection and an intercountry coconut improvement programme. Moreover this option provides a mechanism for ensuring continuity of funding. It reduces overhead costs, due to sharing of common services and governance. And it would have the added advantage of access to other research expertise at IRRI (e.g. biotechnology, plant nutrition, pest control and farming systems).

Disadvantages

Among the disadvantages of this options is that it would require IRRI to provide an international umbrella for a new commodity, such that IRRI's mandate would require modification. Also, being in the typhoon zone, the Philippines is not the ideal location for the primary site of an international germplasm collection. The primary site of the germplasm and the germplasm research unit would have to be located elsewhere in Asia, preferably in Indonesia, to facilitate germplasm exchange.

Option 3: Incorporate an Asian-based coconut research unit within the proposed CGIAR forestry and agroforestry initiative

Advantages

This option allows flexibility in modes of operation with an in-house research capacity, contract research responsibilities, and regional and subject-specific research networks. It enables research to be contracted to NARS and other advanced laboratories. It uses already established links with research on other tree species. Moreover incorporation of coconut research into the proposed CGIAR forestry and agroforestry initiative would allow some common services to be used, thereby reducing costs. Lastly, this option ensures that research related to the sustainability of coconut-based systems will be given priority.

Disadvantages

The disadvantages of this option are that it might not result in a critical mass of expertise and resources focused on coconut. There would be less emphasis on germplasm improvement, and the option might not lead to the easy launching of an international multi-site germplasm collection and an inter-country coconut improvement programme.

9.8.8. Conclusions and Recommendations

TAC concluded that on the basis of many criteria that relate directly to the revised CGIAR mission statement, the priority given to coconut should be higher than would be the case if assessed simply on the basis of its estimated global worth in economic terms. Nonetheless, TAC considered that an entirely new institute for coconut could not be justified.

In its further deliberations TAC took account of the possibilities for expanding coconut research through the portfolio of the proposed CGIAR institute for reserach on forestry and agroforestry, as well as the new opportunities arising from the BUROTROP initiative. Against this background TAC considered that the most urgent need was for an internatinal programme to create a living collection of coconut germplasm and make it available to national breeding programmes. This had been identified by the TAC panel as an area of high priority with Indonesia suggested as the preferred location for such a collection.

Taking all these considerations into account, TAC recommends:

(i) that the CGIAR should support a small initiative on coconut research within the mandate of the proposed institute for forestry and agroforestry;

(ii) that IBPGR should be asked to strengthen its work on coconut genetic resources through a crop-specific network of national programmes.

(iii) that, after the inauguration of the CGIAR forestry and agroforestry research institute, IBPGR should be contracted to establish and

manage on its behalf a coconut germplasm unit in the Pacific region, probably in Indonesia;

(iv) that the forestry and agroforestry institute establish an appropriate process for guidance and oversight of its coconut programme at the level of the Board of Trustees.

TAC envisages that the work of the "germplasm unit" would include collection and characterization of coconut germplasm, as well as the establishment and maintenance of a living collection. Its primary purpose would be to provide source material to national breeding programmes. It would conduct research in collaboration with other institutions on such topics as tissue culture, micropropagation and gene transfer. Its management would be taken over by the forestry and agroforestry institute as soon as practicable, but close linkages with IBPGR and the germplasm network would be retained.

If these broad principles are endorsed by the CGIAR, a detailed proposal should be prepared by IBPGR in consultation with the forestry and agroforestry institute and presented to TAC as part of the institute's mid-term programme and budget.

TAC also considered that if incorporation of coconut into the CGIAR agenda through these institutional mechanisms proved successful, consideration might be given in the future to augmenting work on some other multi-purpose trees in a similar way.

CHAPTER 10 - STRATEGY AND OPTIONS FOR FORESTRY AND AGROFORESTRY IN THE CGIAR SYSTEM

10.1. Background to TAC's Assessment of Forestry and Agroforestry Research in the CGIAR System

The CGIAR System decided to incorporate forestry, broadly defined, into its goal, mandate and programme after considering the serious nature of the forestry and "trees in land use" issues that exist and how they relate directly to the CGIAR's fundamental goal to increase the sustainable welfare of poor people in developing countries. The issues relate to containing deforestation and reducing its negative effects; and to the role of trees and forests in enhancing food and energy security and self-reliance; creating off-farm employment; and ameliorating environmental concerns such as global warming and loss of biological diversity.

The present section reviews very briefly the background on forestry/agroforestry which led up to the decision to incorporate forestry into the CGIAR System. This same background provided an important set of inputs into the TAC deliberations on an appropriate research agenda and the best institutional approach to incorporating a forestry/agroforestry research agenda into the System.

10.1.1. Changing Emphasis in Forestry Development

During the latter half of the 1970s, and particularly during the 1978 World Forestry Congress, a major rethink about tropical forestry strategy emerged. It was a move away from the dominant emphasis on industrial forestry towards more emphasis on "Forestry for People." Speakers at the Congress urged that national governments and aid agencies alike give far more attention to ways of ensuring the essential needs of rural people for fuelwood, fodder, building poles, fruit and many other forest products. Also it focused on improved techniques for reclamation of degraded forest and agricultural lands, for protection of watersheds and options for strengthening rural forestry institutions.

These earlier trends in forestry development and research strategy have been sustained and intensified in the latter half of the 1980s. Both the World Resources Institute's **Tropical Forests: A Call for Action**, published in 1985, with participation of the World Bank and the UNDP, and FAO's **Tropical Forest Action Plan**, published in 1987, also put major emphasis on the above areas of concern.

As a consequence of these changing perceptions during the 1980s, there has been a radical shift in emphasis, both at the national government level and in aid agency support, towards these emerging areas of concern. In contrast with the sixties and early seventies, when about 80 to 90 percent of Official Development Assistance (ODA) for forestry went to industrially related activity, in the eighties some 60-65 percent of all ODA

to forestry is now being directed towards activities related to social forestry (including agroforestry systems), fuelwood conservation and planting programmes, forest conservation, watershed and dryland management for multiple outputs, and strengthening of forestry and related institutions. This trend will continue into the 1990s.

The most relevant conclusion from the above review is that the problems of deforestation will not be solved by focusing only on traditional forestry technologies and issues. What is needed is a holistic approach that integrates agriculture, agroforestry and forestry, both inside and adjacent to encroached forest lands, areas which already contain more than 200 million slash and burn farmers.

A critical need is to assist these farmers in adopting sustainable agroforestry, farming and tree crop management systems. Access to markets, infrastructure, credit and other inputs could provide people with an alternative to slash and burn agriculture. Involvement of forest-dwelling indigenous people in natural forest and open savanna woodland conservation and management can help to save what is left of the fast diminishing tropical forest resources. The key is to integrate more closely agriculture/agroforestry/forestry research activities.

10.1.2. Environmental Concerns Related to Forests

In its overview of background factors to consider in devising an institutional framework for forestry and agroforestry, TAC has noted recent emerging environmental concerns about the impacts of deforestation and forest burning on global warming, loss of biodiversity, erosion, changing water flow patterns and flooding.

Research needs to deal with these problems include a complex blend of atmospheric, meteorological, energy, agriculture, forestry, policy and other research. The CGIAR system has neither the capacity nor the comparative advantage to implement effective research in all of these areas. However, it could make a useful contribution in areas such as conservation of germplasm of endangered woody plant species, policy research aimed at improved understanding of the underlying causes of deforestation and potential solutions, and agroforestry research aimed at providing shifting cultivators with an alternative to slash and burn agriculture and continued forest burning.

10.1.3. The Existing Forestry and Agroforestry Research System

10.1.3.1. The Importance of Regional and National Research

TAC recognizes the site specific nature of much forestry research. As the TAC dialogue on this type of research evolved, it became increasingly obvious that the CGIAR's past commodity

oriented approach to research in agriculture is inappropriate for tackling land use/resource management research problems such as the impact on the sustainability of land use and agricultural productivity of shifting cultivation in situations of increasing population pressure and shortening fallow periods.

Awareness of these issues has influenced TAC's decision to move toward a decentralized institutional framework for forestry and agroforestry that from the outset would involve existing national and regional forestry/agroforestry and other research institutions. Thus, it is desirable that a significant proportion of the resources devoted to forestry and agroforestry research within the System be devoted to strengthening research in the regions through new programmes at some of the existing CGIAR centres and through contractual and collaborative research with regional and national institutions.

10.1.3.2. National Forestry and Agroforestry Research Capacity

Compared with their counterparts in agriculture, many national forestry research institutions are extremely weak; and there are few agroforestry research organizations as such. The implication is that there is an urgent need to devise strong enabling/technical assistance that would complement CGIAR research initiatives by assuring a sustained input of technical assistance for strengthening National Forestry Research System (NFRS) and getting agroforestry research going in both NFRS and NARS.

It would be unrealistic to suggest that the CGIAR system could carry the main financial burden for this type of activity. It is equally clear that the past financing arrangements for strengthening national capacity are inadequate, even though there are a number of mechanisms which have been put in place by FAO and other groups to deal with the problems of forestry research.

10.1.3.3. Integration Between Forestry and Other Research Agencies, Both at the National and International Levels

TAC has noted the historical problem that many forestry research institutions have tended to work in isolation from agriculture and other research agencies. This stems from earlier perceptions that it was the responsibility of foresters to act as custodians of gazetted forest reserves, protecting them from encroachment and managing them for production of timber and for watershed protection.

In practice, as a consequence of rising population pressure and other causes, less than 30 out of 110 developing countries have enough closed natural forest remaining to meet domestic needs for timber, fuelwood and other products and to protect watersheds. Even in these 30 countries, about one-third

of the natural forest has been encroached upon by people and livestock. Foresters today face the urgent need to improve productivity of remnants of natural forests and to reforest degraded forest and agricultural lands under conditions of heavy population pressures, often with the added complications associated with common property or open access tenure arrangements.

The implication is that specialized forestry research institutions focusing only on problems of natural forest or plantations for commercial and/or protection purposes will not be addressing the main forest/people problems of the developing world.

Both at the national and international levels forestry research institutions increasingly need to incorporate agronomic, sociological, ecological and other disciplines into their staffing structure in addition to traditional silviculture and tree breeding specialists. They will need to develop strong linkages with agriculture and other specialized agencies which can contribute to solving problems related to sustainable land use systems.

In putting forth the above points, TAC is not implying that traditional forest management dealing with timber production, forest conservation and so forth are not important topics which need research. Rather, TAC is recognizing the emerging trends as forestry is coming face to face with the problems of rapidly increasing populations, loss of natural forest, and increasing degradation of remaining forests.

10.1.4. Changing Emphasis in Forestry Research Priorities

10.1.4.1. Creation of ICRAF

As a response to an awareness of the above issues, ICRAF was created in 1978 with a mandate to promote and develop agroforestry research. During the past decade it has made a significant impact by increasing awareness of the need to bring agriculture and forestry closer together in the development of more sustainable land use systems. Research methodologies have been developed based on a farming systems approach to identifying key problem areas and research topics that would enhance the contribution of trees and natural woodlands to soil fertility, fodder supplies, increased agricultural productivity, and to food and energy security in general.

Notwithstanding ICRAF's efforts and even considering that some NFRs are moving toward the newer, broader view of forestry and trees in land use, many forestry research institutions still remain narrowly focused on more traditional areas of forestry concern. While such research is needed, it must be supplemented by a significant shift to take care of the newer concerns discussed above.

10.1.4.2. Creation of the IUFRO/SPDC

At the 1981 IUFRO Congress, a World Bank/FAO (1981) paper recommended a re-orientation of research to back up the newly emerging forest development priorities. It gave much stronger emphasis to socio-economic research at the farm and village levels to understand people's perceptions of the usefulness of trees and a shift in tree selection and improvement from a narrow range of industrial species to a wider range of multipurpose tree species to give an increased focus to multiple end uses. It recommended broadening the objectives of natural forest management to incorporate multiple end use objectives with more emphasis on non-wood forest products.

As a follow up to the World Bank/FAO recommendation, the 1981 IUFRO Congress recommended establishment of the IUFRO/SPDC. The SPDC was not set up as a research centre, which in any case would have been inappropriate given the nature of IUFRO, rather it was set up as a small catalytic programme charged with the task of working collaboratively with national forestry institutions and helping them to identify and secure financial support for research programmes. In recent years, the SPDC has increasingly become involved in training activities and in building up a database related, for example, to research funding sources.

10.1.4.3. The Bellagio II Task Force on Forestry Research

The next significant step was the decision to hold a Bellagio II meeting to discuss the state of tropical forestry research and to suggest concrete action to improve the situation. The ITFFR (International Task Force on Forestry Research) was set up in 1988 to address itself to the issue of need for strengthened international institutional arrangements for forestry research. The Task Force members (12 highly respected forestry, agriculture and socio-economic scientists and NGOs drawn from both developing and developed countries) had vigorous interactions with national and regional forestry research institutions in the process of preparing their report and recommendations.

The recommended programme of research suggested by the ITFFR gave strong emphasis to:

- Agroforestry and watershed management research
- Natural forest ecology and management
- Tree selection and improvement
- Utilization and marketing
- Policy and socio-economic research.

In addressing future modes of operation for forestry research, it took into account the changing trends in tropical forestry and recommended that:

> " A major area of weakness in most countries is the lack of interaction between forestry and agricultural researchers.... Mechanisms for improving the interaction of forestry and agricultural research need to be developed."

The Bellagio II meeting endorsed the ITFFR recommendation to integrate various areas of forestry and agroforestry related research. Specifically,

> "All aspects of forestry research need to be integrated, including agroforestry, social forestry at the village and farm level, through to the issue of forest land management which may impinge on the preservation of biodiversity in wilderness areas. The same applies to the use of forest land for commercial purposes."

However, the meeting participants did not endorse the idea of a separate forestry research institutional mechanism and consortium of donors. Rather, they endorsed the idea that forestry research should be incorporated within the CGIAR System, partly because of the obvious linkages with agriculture.

10.1.5. TAC's Adoption of an Integrated Approach to Forestry and Agroforestry

The above background explains clearly why during the TAC debate on forestry and agroforestry, many TAC members and many informal review panel members expressed concern about the initial separation of forestry and agroforestry in the earlier TAC deliberations. It also emphasizes the importance of trying to integrate agriculture and forestry research and to maintaining a strong policy-based emphasis in CGIAR-supported forestry research programmes.

A view which has emerged from TAC's discussions with many outside experts on this topic is that continued separate treatment of forestry and agroforestry will encourage foresters and forestry researchers to revert to the narrow definition of forestry development that prevailed before the mid 1970's.

An integrated model would provide better prospects for ensuring the relevance of forestry research to dealing with the above questions. This is because not only agroforestry, but also much of forestry research, requires a combined systems approach taking into account farmer, villager and forest-dwelling people's perceptions of the usefulness of trees, choice of species, and appropriate tree/wood lot/forest management systems.

The objectives of natural forest management in the humid tropics have been shifting from timber production (which in the past has been based on the selective logging of high value species for export) towards multiple end use management for production of food, fodder, timber, medicinal and other products

for indigenous consumption. Similarly, in the savanna woodlands of Africa, for example, fodder, fuelwood, and non-wood products are now of greater importance than timber production. A starting point not only for agroforestry but also for much forestry research therefore must be a multidisciplinary systems approach, taking into account people's perceived needs.

In sum, based partly on the above considerations and partly on internal considerations related to the mandate and goals of the CGIAR, TAC, in developing its recommended strategy and approach for research in forestry and agroforestry, took as its guide the following basic set of premises and assumptions (not listed in any order of importance):

1. Given the nature of the key forest and tree related problems that the CGIAR wishes to tackle, TAC should consider the best ways in which the relevance of research can be enhanced by more closely integrating agriculture, agroforestry, and forestry.

2. The major emphasis of CGIAR-supported forestry and agroforestry research should be at the regional/national levels, given the decentralized and site specific nature of much forestry and agroforestry research and the need to involve NARS and NFRS in building up research experience and capacity. The approach needs to build on a consultative process to insure that local needs are considered and met.

3. The CGIAR initiative should build on the work of existing regional, national and specialized forestry/agroforestry institutions.

4. The CGIAR approach should build on the existing work in agroforestry and trees in land use in the CGIAR centres.

5. The CGIAR System cannot and should not be everything to everyone. Thus, selectivity in setting research priorities is essential.

6. TAC should consider explicitly the System's resource constraints and potentials for introducing efficiency and effectiveness into the components of the recommended initiative for the CGIAR System.

7. The CGIAR initiative should be in harmony with and support the current trends in overall official development assistance for forestry related activity.

8. TAC should view the introduction of a forestry/agroforestry initiative as involving an evolutionary and dynamic process, starting small, building onto ongoing programmes and eventually reaching a significant level of activity as each stage in the process proves itself and new blocks are added to the growing initiative.

9. With regard to ICRAF's role in the overall recommended CGIAR initiative in forestry and agroforestry, TAC took as a starting point its "Strategy to 2000", which has been approved by its board and endorsed by ICRAF's donors.

10. As the CGIAR initiative is being designed and being built up, there is a critical need to assess in parallel the mechanisms needed to ensure that that part of the total research agenda which falls outside the scope of the CGIAR activity also is moving forward.

10.2. The Proposed CGIAR Research Agenda and its Relationship to the Agendas of Other Programmes

The following choice of illustrative topics recommended for the CGIAR research agenda in forestry and agroforestry is based on an exhaustive assessment reported in earlier TAC documents (listed in Annex IX). This assessment was complemented by dialogue with some sixty leading forestry, agricultural and agroforestry experts. The following topics emerged (illustrative only) as examples of the research topics that would lend themselves well to CGIAR support:

- Agroforestry, with special reference to research methodology, improved quantification of tree/crop/livestock interactions and development of improved agroforestry practices.

- Conservation of woody germplasm, especially of important commercial agricultural and forest crops.

- Selection, breeding and improvement of multipurpose trees for agroforestry/fuelwood/industrial and other uses. This includes emphasis on seed and clonal propagation, and on tissue culture research.

- Natural forest management and conservation. This includes research on growth and yield modelling, silvicultural techniques for sustainable production of multiple products, management of secondary natural forests for multiple products, gap studies related to production of multiple products.

- Man-made forest management. This includes selected areas of silvicultural research (particularly growth and yield modelling studies) relevant to increasing the productivity and improving reforestation techniques. Special attention would be given to reforestation techniques for reclamation of agricultural wastelands and for increasing fuelwood/forest biomass output.

- Soil microbiology, nitrogen fixation, mycorrhizal and associated soil nutrient relationships, and selected aspects of pathology and entomological research,

particularly as all of these supporting fields relate to the areas of research mentioned previously.

- Socio-economics and policy research with special reference to developing better understanding of the underlying causes of deforestation and potential solutions, and to improving understanding of incentive mechanisms for involving local people in forest conservation and tree growing.

10.2.1. The Research Agendas of Other Programmes

It is important to understand how the above proposed CGIAR research agenda relates to those of other organizations and programmes, including particularly the ICRAF agenda and the Bellagio II agenda. It is important to know what parts of these agendas overlap with the proposed CGIAR agenda; and to what extent the proposed CGIAR agenda includes areas of research not considered in other agendas.

10.2.1.1. Bellagio II Research Agenda

This agenda was introduced briefly in the previous section. Basically, it revolves around five major research or issue areas (see also Table 10.1.):

- Agroforestry, fuelwood and watershed management
- Natural forest ecology and management
- Tree breeding and tree improvement
- Utilization and market research
- Policy and socio-economic research.

As will be illustrated at a later stage, the proposed CGIAR forestry and agroforestry research agenda is well-placed to make a useful contribution to most of the research priorities identified by the Bellagio II Task Force. The CGIAR's goals of improving the sustainability of agricultural systems and its focus on the problems of the rural poor and on improving environmental policies, fit well with the strategies needed for tackling deforestation, which was one of the main driving forces behind the Bellagio II activity.

10.2.1.2. ICRAF's Research Agenda

In its recently completed "ICRAF: Strategy to 2000" paper, ICRAF spells out an integrated programme of strategic, applied and adaptive research. It proposes concentration on four main programme areas:

Table 10.1. Forestry research priorities as defined by the Bellagio II Task Force.

Priorities by Research Fields	Main Emphasis
1. Agroforestry and Watershed Management Research	
1.1 Agroforestry research	• tree/food crop interactions (e.g., alley cropping) • tree/pasture interactions (e.g., effects of shade, nitrogen-fixation and fodder relationships) • shelterbelts (effects on long-term productivity of sheltered crops and animals • fuelwood production on farms using multipurpose tree species
1.2 Watershed management research	• identification and quantification of upstream/downstream interrelationships • effects of alteration of land-use practices • use of agroforestry practices to reduce erosion • options for fuelwood and fodder production and improved livestock management practices, such as stall feeding to take pressure off fragile natural forests
1.3 Dry zone woodland management research	• low-cost technologies for improving sustainable productivity of fuelwood, fodder and other needed outputs
2. Natural Forest Ecology and Management Research	
2.1 Species identification and classification and ethnobotanical research	• human uses of the various species from the tropical forest
2.2 Ecosystem conservation and maintenance of biological diversity	• structure and functioning of tropical forest ecosystems identification, collection, and storage of germplasm
2.3 Management for sustained yield wood production	• maintenance of forest quality and biological diversity within the natural, managed forest • forest inventory with remote sensing and monitoring • ecological foundations for sound sustainable management practices • research on tree pests and diseases
3. Tree Selection, Improvement and Establishment Research	
3.1 Selection and improvement of multipurpose tree species	• seed collection and storage, species and provenance trials on both native and exotic species which can be used within agroforestry systems and by rural communities in meeting their basic needs, including fuel, fodder, food and construction materials • nitrogen-fixing species • salt and stress tolerance in dry zones
3.2 Selection and improvement of fast-growing industrial tree species	• species adapted to particular agroclimatic conditions and product needs • continued work on eucalypts, pines, rubber and other well-known producers
3.3 Tree and stand establishment	• establishing trees on adverse sites • improving nursery practices • afforestation and reforestation technologies

Table 10.1. continued

Priorities by Research Fields	Main Emphasis
4. Utilization and Market Research	
4.1 Utilization of lesser-known species and nonwood products from the tropical forests	• utilization technologies that can be widely disseminated and adopted by local communities, given their skills, the availability of labor and other relevant factors
4.2 Research to adapt already-existing technologies to local conditions	• to be locally determined
4.3 Local market studies and research on market structures and functioning	• to be locally determined
5. Policy and Socioeconomics Research	
5.1 Policy reforms in forestry and other sectors to promote reductions in deforestation	• to be locally determined
5.2 Potentials for increased government rent capture for utilization of natural tropical forests	• how to link increased rent capture with improved management to increase sustainability of natural tropical forest management
5.3 Understanding better the incentives which motivate smallholders to grow trees	• effectiveness and efficiency of alternative incentive mechanisms designed to stimulate local participation in tree-growing and conservation activities
5.4 Integrated watershed management research	• systems studies of integrated watershed management options to reduce on-site and downstream damages from erosion, streamflow alterations and water pollution • policy options and incentive mechanisms to encourage sound land use
5.5 Promotion of small-scale sustainable industry	• relation between raw material supplies and employment creation

- Agroforestry and land use systems;
- Component interactions in agroforestry systems;
- Multipurpose tree improvement;
- Agroforestry policy and institutional issues.

ICRAF further classifies research issues which need to be addressed in these four programme areas into biophysical and socio-economic topics.

10.2.2. Areas of Commonality in Research Thrusts: ICRAF, Bellagio II, and Proposed CGIAR Agenda

Given the concern that the TAC proposed research agenda might not give enough attention to all the areas of the Bellagio II research agenda, as well as the concern that agroforestry research problems as defined by ICRAF may be neglected, it is relevant to examine more systematically the ***commonality*** between the major research priorities as defined by the Bellagio Task Force, by TAC and by ICRAF. This is done in Table 10.2.

From Table 10.2. it is clear that there is, in fact, a very high degree of commonality between the major research thrusts identified in the independent evaluations carried out by the Bellagio Task Force, by TAC and by ICRAF.

Importantly, all three programmes recognize the point made earlier that trees play an important role in a wide range of land use systems, and have potential to make a significant contribution to maintaining agricultural productivity; to meeting fuelwood, tree fodder, fruit, pole needs; to income generation; and to protection of crops, livestock and water resources. These topics will be a major thrust of both forestry and agroforestry development in the coming decade.

10.2.3. Areas of Forestry Research That Would Not Be Covered by the CGIAR

From the outset of the dialogue concerning the entry of forestry and agroforestry into the CGIAR system, it has been acknowledged that the CGIAR cannot take on all areas of forestry and agroforestry research. Specifically excluded from the TAC recommended research agenda are:

a) Research that TAC deems as not relating directly to, or not having high priority in terms of, the mission and goals of the CGIAR System;

b) Research on topics which, despite their relevance to the CGIAR mission and goals, are of a nature such that the System has no particular comparative advantage;

c) Adaptive research.

Table 10.2. Commonality of research thrusts.

AS DEFINED BY THE BELLAGIO TASK FORCE	AS DEFINED BY TAC	AS DEFINED IN ICRAF's RESEARCH AGENDA
1. Role of forests, woodlands and on-farm trees in contributing to agricultural productivity and sustainable land use (including soil fertility, microbiology, mycorrhizal organisms, role of N-fixing trees, pests and diseases). Tree management systems: both intercropping and monoculture.	1. Role of forests, woodlands and on-farm trees in contributing to agricultural productivity and sustainable land use (as per Bellagio including soil fertility, soil microbiology, mycorrhizal organisms, role in N-fixing trees, including both intercropping and monocultures and selected areas of pathology/ entomology.	1. Role of trees in contributing to crop/livestock productivity, sustainable land use. Soil fertility use of tree/foliage/ mulching, N-fixing, soil mycorrhiza associations. Selected areas of pathology/entomology. Primary emphasis on intercropping but excluding monocultures. Emphasis on nongazetted forest lands.
2. Conservation, selection, breeding and improvement of MPTS, particularly N-fixing species for on-farm agroforestry, wasteland reclamation fuelwood, fodder, cash crop tree farming and industrial planting.	2. Conservation of woody germplasm. Selection, breeding and improvement of MPTS (for a wide range of situations) (as per Bellagio). Special emphasis on nitrogen-fixing trees.	2. Genetic resources selection, breeding and improvement of MPTS for agroforestry systems as per Bellagio but excluding industrial species.
3. Natural forest ecology management and conservation of biodiversity.	3. Selected areas of natural forest ecology and plantation management that can benefit from centralization (e.g., modeling of growth and yield, gap studies, autecology of individual species). This could be linked to regional research networks covering, for example: (a) adaptive research relating to some of the silvicultural options for natural forest management (b) adaptive silvicultural research relating to, e.g., planting, fertilizing, weeding, thinning, pruning for intensive biomass regimes and/or wider-spaced commercial plantation forestry.*	3. Tree management systems in intercropping situations (pollarding, coppicing, etc.) and for farm woodlots where these are integrated into the farming systems. Excludes industrial plantation silvicultural management systems.
4. Utilization and forest products research: (a) Timber testing (b) Forest products engineering (c) Improved understanding of potential of underused minor forest products.	4. Selected areas of utilization relating to improved prospects for utilization of so called minor forest products from natural forests (bamboo, rattan, etc.). Small-scale rural enterprises, particularly related to use of farm and community tree outputs.	
5. Socioeconomic policy research: (a) Macro, e.g., improved understanding of underlying causes of deforestation, agricultural settlement, land tenure policies, intersectoral linkages. (b) Micro, e.g., incentives for reforestation, equity and gender issues.	5. Policy research both macro and micro as defined by Bellagio (see 5(a) and 5(b).	5. Socioeconomic policy research (mainly at the micro level), special emphasis on: • Land tenure • Equity • Gender • Cash crop potential • Pricing policies (as per 5(b) of Bellagio)

* Such adaptive research networks would be similar in approach to ICRAF's AFRENA agroforestry regional networks in Africa.

10.2.3.1. Research Topics That Do Not Fit Within the CGIAR Mission and Goals

The mission and goals of the CGIAR relate to improvement of the lives of poor people in developing countries and to increasing the sustainability of the production systems on which they rely. There are certain types of activity (particularly, those related to, for example, large scale, primarily export-oriented, industrial timber production, harvesting and processing) that do not conform sufficiently to the mission and goals of the CGIAR to be included in the agenda.

While such activity can provide jobs for poor people, the relationship is less direct than in the case of other activities. Thus, there are other priority areas which can have a more direct and a greater impact on the welfare of poor people. These were given higher priority in the proposed agenda. For these same reasons TAC has excluded areas of research such as road construction, timber resource inventory and monitoring techniques, large scale industrial processing and wood utilization, logging, extraction methods, and marketing of products such as timber/pulp and paper. It is emphasized again that exclusion of these topics does not imply that TAC thinks they are unimportant.

10.2.3.2. Areas of Research in Which the CGIAR Has No Special Advantage.

For some areas of research, e.g. remote sensing, forest inventory, satellite monitoring and global climate change studies, the CGIAR, at this point in time, has no special advantage. There are many well-established international scientific institutes already working on these topics.

This point also applies particularly to improved understanding of natural forest ecosystems (a high priority for many of the agencies interested in natural forest conservation). It is difficult within the framework of CGIAR's current priorities and strategies mandate to develop a case for long range and diffuse scientific inventory research aimed at developing better understanding of the interactions of the literally thousands of tropical forest plant, insect and animal species.

While understanding such interactions is indisputably of importance to future generations, there are other agencies such as IUCN, the Conservation Foundation, WWF, WRI and others that already are working actively on a more concerted international effort to understand and to protect the biological diversity of tropical rainforests and to minimize the risk of species extinction. While the CGIAR System has collaborated, and should continue to collaborate with such groups, it has no particular advantage in these areas, and there are other areas of research which have greater direct priority in terms of its mission and goals.

10.2.3.3. CGIAR Involvement in Adaptive Research

A high proportion of forestry research is species and site specific, is adaptive in nature, and therefore has a relatively small area for potential application. Much of the ongoing forestry research work in the tropics is conducted by national research institutions. They work on increasing the productivity and sustainability of specific existing natural forests via such techniques as controlling logging operations aimed at protection of natural regeneration, on in situ conservation of tropical forest resources, on nursery and establishment methods for specific species, and so on. This type of adaptive research would not benefit particularly from centralization and is excluded from the research agenda proposed. On the other hand, some of the suggested CGIAR research related to methods of seed production, storage and germination, seed biology; methods and techniques for in situ conservation; tree establishment and silvicultural techniques, is included in the recommended agenda.

The fundamental differences between strategic/applied and adaptive research and the fact that the CGIAR system would not play a major role in the latter area has led to concerns being expressed by some of the forestry community that the CGIAR will make only a limited contribution to forestry research.

It is important to emphasize that there is a high degree of complementarity between strategic, applied and adaptive research along the technology continuum. Notwithstanding the argument that adaptive research is primarily a NARS/NFRS function, many CGIAR centres indirectly support adaptive research networks (e.g. CIP, CIAT, etc.) by developing complementary programmes with adaptive research groups through various collaborative mechanisms. The same is likely to apply to forestry and agroforestry research.

To illustrate, effective in situ conservation of genetic resources of forest tree species by national institutes has benefited from a centralized input from FAO and could benefit from an input by IBPGR relating to such topics as:

- Standards and advice on ex situ seed conservation
- Methodologies for sampling techniques
- Methodologies for computer-generated keys
- Methodologies for assessing patterns of variation and planning collecting to cover ecogeographic ranges and maximize the capture of variation.

Centralized CGIAR-supported research on clonal propagation and tissue culture methods would be of direct relevance to national and regional tree breeding and adaptive tree improvement networks. Similarly growth, yield and modelling studies carried out by a CGIAR-supported central forestry research institute could have significant implications for the design of adaptive research networks, for example, for testing alternative spacings for intensive biomass production. Centralized and CGIAR-

supported work on soil microbiology, nitrogen fixation and work on soil mycorrhizal associations would be of direct relevance, both to enrichment planting in natural forests and to improving the productivity of plantation monoculture regimes.

Related to the above points, it should be kept in mind that:

a) there are many "grey areas" along the continuum of strategic/applied/adaptive research, and the choice of an exact programme of research can only be made by the management and Board (and approved by TAC) once a specific institutional setting and budget range have been established;

b) TAC emphasizes that it views the process of getting forestry and agroforestry research firmly established in the CGIAR System as an **evolutionary** one that will involve a process of successive iterations as the system evolves. Thus, the detailed research agenda discussed below can only be considered illustrative of the specific types of research problems which will be addressed.

c) TAC fully recognizes the importance of working closely with the rest of the world community involved in forestry and agroforestry research. Recognizing this point, Section 10.7 of this paper deals with the topic of complementary programmes in more depth.

10.3. Overall Operational Strategy and Plan for Incorporation of Forestry and Agroforestry into the CGIAR System

TAC has proceeded in an evolutionary way as it moved toward defining an optimum overall strategy and plan for incorporation of forestry and agroforestry into the CGIAR System. Part of the process involved definition of an appropriate research agenda. This was discussed in the previous section. A second part of the process, covered in this section, was to develop an overall strategy for implementing the agenda within the CGIAR System.

The suggested overall strategy includes four main elements, two of which focus on regional and national level research activity, and two on global activity (see Table 10.3). As discussed earlier, the main focus will be on regional/national research. For purposes of this initial assessment, TAC assumed that about 70% of the activity would be in the regional and national component and about 30% in the central component. A brief overview of the components follows, with detailed discussion of each in Sections 10.4 and 10.5.

Table 10.3. Proposed Four-Pronged Approach to Forestry and Agroforestry Research in the CGIAR System

CGIAR INVOLVEMENT / SCOPE OF ACTIVITY	NEW ACTIVITY (or incorporation of existing activity in the CGIAR System)	EXISTING IARCS
REGIONAL/NATIONAL	Contractual and/or collaborative research with selected regional, national, and specialized forestry and agroforestry research institutions and networks; (with outposting of scientists from the new central mechanism and possibly from existing CGIAR centres); (see Section 10.4.)	Expanded forestry/agroforestry (FAF) research in selected IARC's, e.g., IITA, CIAT, ICRISAT, ILCA, ICARDA, with some AEZ focus; (expanded interaction of these programmes with regional and national centres and with a central CGIAR FAF mechanism); (See Section 10.4)
GLOBAL	Creation of a centralized mechanism that would: • serve as a focal point for forestry and agroforestry research in the system; • do hands-on research (strategic and some applied); • contract and collaborate with national and regional institutions (making the link to applied and adaptive research) • develop an international database for use by the whole CGIAR System and national and regional organizations/scientists • provide training and other centralized services as deemed desirable as the system evolves; (See Section 10.5.)	Strengthened FAF research capability and capacity in IFPRI, IBPGR, and ISNAR, to be built up gradually and initially with some flexibility to determine the mix of activities in these centres vs. in the proposed central FAF mechanism; (IFPRI already is moving ahead with its involvement and is planning an international workshop on forestry and agroforestry research for February of 1991 to better define its potential role in relation to that of the new centre; it should be noted that while these activities are listed here as global, they will have to have a very specific national/regional focus in many cases);

10.3.1. Regional/National Activities

Recognizing that the bulk of CGIAR-sponsored forestry and agroforestry research should be carried out at the regional and country levels, TAC recommends that the CGIAR initiative should:

- Assist selected CGIAR centres, particularly those with relatively clear regional agroecological mandates, such as IITA, CIAT, ICRISAT, ICARDA and ILCA, to become more involved in research related to "trees in land use";

- undertake contractual and collaborative research with national and regional research institutions (both forestry and agriculture). The main thrust of CGIAR supported research at the regional and country level would relate to activities as defined earlier by TAC, e.g. tree improvement, crop/livestock/tree interaction, natural forest management and conservation, and forest policy and socio-economic research.

10.3.2. Global Activities

In order to support the above national and regional research activities, TAC recommends that the CGIAR:

- **Strengthen the forestry and agroforestry capability of IBPGR (the areas of woody germplasm collection and evaluation), IFPRI (in the areas of macro-economic forestry and agroforestry policy), and ISNAR (in the areas of strengthening national and regional forestry and agroforestry research institutions);**

- **Develop a centralized mechanism** that would act as a focal point for forestry/agroforestry research and backstop regional/national research supported by the CGIAR. The central mechanism would also undertake contractual and collaborative research with both national forestry and agroforestry research centres and support network research. More specifically, the proposed central CGIAR mechanism might have the **following illustrative functions:**

  - Serve as a focal point for forestry and agroforestry research in the CGIAR System, with responsibility for linkages with Centres, regional/national institutions, FAO, etc., engaged in forestry and agroforestry research and research support.

  - Carry out hands-on research in areas identified by TAC and by the implementing agency and the new board of the central mechanism.

  - Strengthen national and regional forestry and agroforestry research capacity and activity through contractual and collaborative relationships with existing research institutions and networks. Researchers in the central mechanism would be actively involved in this work and in networking activity which would focus initially on strengthening of on-going forestry/agroforestry networks and programmes that meet the CGIAR's criteria;

  - collaborate with non-CGIAR institutions involved with technical assistance and institution building in the areas of forestry and agroforestry;

  - Develop data base and research information dissemination functions in close collaboration with other groups involved in this type of activity;

  - Undertake and/or sponsor research training activities;

  - Other functions as needed and deemed appropriate as the programme evolves.

From early on, TAC considered it logical that ICRAF might be approached to become the central mechanism in the overall initiative, since this could involve cost savings and could speed up the process of implementation of many of the recommended thrusts.

10.4. Regional Research Thrusts and Institutions

This section provides an overview of the regional thrusts which TAC identified as illustrative of what might be included in the overall CGIAR initiative in forestry and agroforestry. It should be emphasized here that the main reason for carrying out this regional assessment is not to recommend a specific research agenda for the regions (which can only emerge from more in-depth consultation at the regional and national levels), but rather to provide some indicative programmes and to provide the background for defining the nature and structure of a central mechanism to support the regional activity, and for estimating a rough order of magnitude budget for the CGIAR initiative.[1]

10.4.1. Main Topics Covered in Regional Thrusts

The illustrative regional research thrusts which emerged from the TAC assessment are summarized in Annex IV, Tables 1. The areas discussed are:

- Agroforestry, including agroecological zoning/land use capability/methodology and applied research, component interactions in agroforestry systems, root symbiosis, (e.g. N-fixing symbiosis), moisture competition effects on crops and trees, on-farm tree management/silvicultural methods.

- Collection/characterization/evaluation of woody germplasm, including methods of seed production and germplasm conservation.

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[1] Several recent studies provided the basis for defining possible regional research thrusts. This analysis built particularly on those regional research studies that involved intensive interaction between the *implementing agency of the study and national/regional forestry and agricultural research institutions.* The main studies used include:

- A World Bank/FAO study carried out in 1981 of emerging developing-country research priorities
- Five IUFRO/SPDC regional workshops carried out in conjunction with national forestry research institutions in the Asia, Africa and Latin American Regions
- Several earlier comprehensive reviews by FAO of research needs in the regions.
- Numerous reports by bilateral programs of e.g. CTFT, CSIRO, USAID, IDRC, ODA, GTZ, DANIDA, FINNIDA, SIDA, IDB, ADB and others.
- Past studies (mainly in Africa) of agroforestry research priorities by ICRAF, which has made a special point in developing its own research agenda, of interacting with national, mainly, agricultural research institutions.
- Studies carried out in 1987/88 by the Oxford Forestry Institute in conjunction with national forestry research institutions in East, Southern and Western Africa.
- The report of the Bellagio International Task Force on Tropical Forestry Research (1988) which consulted widely with both national and regional forestry and agricultural research institutions and prepared working papers on regional research thrusts.
- A TAC/CGIAR Interim Expansion paper which is an input to the revised CGIAR Strategies and Priorities Paper due in 1992.

- Genetic improvement of multipurpose tree species, including provenance selection, breeding, and evaluation.

- Forest conservation/management and silvicultural research, including agroecological zoning/forest land use capability, standardized methods for biological research gap studies, soil microbiology, biomass and nutrient cycling, silvicultural growth/yield and other modelling studies and applied research aimed at improving the productivity of natural forests and plantations.

- Policy and socio-economics research, including improved understanding of the underlying causes of deforestation and of policies that would encourage people's involvement in conservation and sustained yield management of natural forests and accelerated rural afforestation.

In the area of agroforestry, a deliberate attempt was made to build on the ongoing and planned programmes for expansion of agroforestry research by some of the existing IARCs (particularly CIAT, IITA, ILCA and ICRISAT). Where possible, these proposed IARC agroforestry programmes were set within the framework of the four main agroforestry research thrust identified in ICRAF's "Strategy to 2000" document.

- Agroforestry land use systems
- Component interactions in agroforestry systems
- Multipurpose tree germplasm improvement
- Agroforestry policy/institutional issues

The likely interest of IBPGR, IFPRI and ISNAR in supporting regional agroforestry/forestry research was also recognized and account taken of the potential of these three centres to contribute as follows:

IBPGR: Collection and evaluation of woody germplasm
IFPRI: Policy research
ISNAR: Strengthening of research management and management training

The above centres are in the process of planning for incorporation of forestry into their programmes.

10.4.2. National and Regional Research Institutions[1] [2]

An analysis of regional institutions involved in forestry/agroforestry research is set out in Annex V. ***Illustrative examples*** are given of some of the more obvious national and regional forestry and agricultural research institutions with which a centralized CGIAR forestry/agroforestry

[1] See earlier TAC study, "International and regional organizations and networks involved in tropical forestry research: A stock taking." May 30, 1989.

[2] See TAC/RMFA Panel draft: "National forestry research systems in developing countries." June, 1990.

research centre(s) might want to collaborate in each of the major research areas.

It should be emphasized again that this only is an illustrative exercise. The purpose is not to suggest that the institutions identified here would be the only ones with which the CGIAR would be concerned (or alternatively that it would collaborate with all of them). The purpose was, first, to illustrate the wide range of institutions that are involved in forestry and agroforestry, and second, to provide a basis for a discussion of likely costs of regional programmes and the likely administrative and financial mechanisms that would need to be put in place for contractual, collaborative or other research linkages between a central institute(s) and research agencies in specific regions.

In both Asian and Latin American countries, and also in a few African countries, it is possible to identify some leading NARS/NFRS that could play a role as nodes for CGIAR-funded regional networks, or as potential implementing institutions for contractual research in situations where research results would benefit several countries in a region. Examples are FRIM in Malaysia which has well-developed research capability in the utilization of lesser known species. This research is of wide applicability in the Southeast Asia region. The work of EMBRAPA in Brazil on technologies for reforestation of acid forest soils is of particular relevance to other Latin American countries. The work of FRC Zimbabwe, which has had more than 20 years experience of tree breeding and improvement programmes, originally in industrial species but more recently on multipurpose species, is of wider applicability in the SADCC region countries of Africa.

However, it also is clear from FAO studies and the Bellagio Task Force work that the opportunities for effective research networking in both forestry and agroforestry will be severely constrained for many years to come by the weakness of many national agriculture and forestry research institutions.

It follows that a substantial input of "enabling" technical assistance will be necessary if research networks in forestry (and agroforestry) are to be successful and are to meet the types of criteria defined for successful networks.

10.4.3. Regional Experience of the CGIAR Centres

Some CGIAR centres (e.g. CIAT, IITA, ILCA, ICRISAT, ICARDA) have ongoing involvement in some aspects of agroforestry research, particularly related to selection and evaluation of nitrogen-fixing MPTs for incorporation into farming systems and their potential to contribute to soil fertility and livestock fodder needs.[1]

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[1] "International and Regional Organizations and Networks involved in Tropical Forestry Research: A Stocktaking" TAC AGR:IAR/89/7 June 19, 1989. See Annex V. See also recent Annual Reports of ICRISAT, ILCA, IITA and CIAT).

TAC notes CGIAR centre proposals for expanding their work in this area.

Given the current dialogue within the CGIAR System about the possibility of some of the existing Centres taking on an expanded resource management oriented research agenda and possibly becoming so-called "ecoregional centres", consideration could be given to the possibility of some of the existing Centre's becoming focal points for implementation of regional/agroecological-focused resource management research activity relating to forestry, agroforestry and agriculture.

10.4.4. Experience of Existing Specialized Organizations

A key point emerging from the analysis is that, in each of the three major regions covered, there already exist well-developed "twinning" arrangements between national forestry (or agricultural) research institutions in developing-country regions and long-established specialized agriculture/forestry research centres, mainly in the developed world but also in some developing countries. These centres have expertise that is highly relevant to both tropical forestry and agroforestry research. In many cases, they could implement parts of the overall CGIAR forestry/agroforestry programme more efficiently and effectively than the new centralized mechanism. Thus, contractual and collaborative arrangements need to be considered in such cases. Examples of such agencies are presented in Table 10.4.

10.5. Institutional Options for a Centralized Mechanism in the CGIAR Forestry/Agroforestry Initiative[1]

TAC started with a "clean slate" approach, i.e. assuming no institutional constraints and existing mechanisms. The objective was to design a central mechanism within the four pronged approach to forestry/agroforestry which could effectively and efficiently address the research topics identified as having high priority and high potential for making major contributions to resolving issues that directly relate to the mandate and goals of the CGIAR System. In looking at alternatives, TAC considered the premises and assumptions outlined in Section 10.1 and assumed an upper limit on annual resources of about $40 million, which was the target set for incremental funding for forestry/agroforestry research by the Bellagio II Task Force, minus $10 million which could go to funding research in the subject areas not taken on by the CGIAR. (see Annex VII for an illustrative budget breakdown by regions and key institutions.

[1] See TAC/RMFA Panel Paper: "Comparing Institutional Options for Incorporating Forestry and Agroforestry into the CG System." August 14, 1990.

Table 10.4. Examples of specialized agencies involved in forestry and agroforestry research

CSIRO and ACIAR have strong linkages with national research institutions mainly in Asia and Africa in relation to its programmes and for selection and improvement of Australian tree species suitable for agroforestry and other purposes
Tata Energy Research Institute in India which is a leader in energy-related (including fuelwood) research
CTFT in France, which has well-developed linkages with national research institutions in mainly West Africa and long experience in both natural forest management and arid zone forestry/agroforestry research
OXFORD FORESTRY INSTITUTE (UK), which has well-developed linkages in all three regions and special expertise in the areas of collection/evaluation of woody germplasm MPT, breeding and improvement, policy research needs of both forestry and agroforestry and tropical silviculture
ITF, Puerto Rico, has research in regeneration and management technologies for secondary tropical forest
CATIE in Costa Rica, which has experience in the areas of MPTS, community and agroforestry research
WINROCK INTERNATIONAL, which, with USAID support, has developed strong linkages with Thailand and national forestry research institutes in several Asia region countries, with special reference to selection and improvement of MPTS for agroforestry and other purposes
IDRC, which has developed research networks for selected species (e.g. bamboo, rattan in Asia) and agroforestry research trials in several African and Latin American countries
NFTA in Hawaii, which has strong linkages with national institutions and regional CGIAR centres in relation to breeding and evaluation of N-fixing MPTs
ICIMOD in Nepal, which has a multidisciplinary research team working on improved understanding of policy options and improved technologies for sustainable land use in upland watersheds
THE EAST-WEST Centre in Hawaii which has carried out many socioeconomic policy and other research studies of relevance to countries in the Asia/Pacific region
ITTO in Japan, which is developing linkages with forestry and policy research institutes in Indonesia, Philippines, etc., and has sponsored a number of significant studies

The options considered for a centralized mechanism include those which take into account a) the existence of ICRAF as a major actor in the agroforestry field (with an annual budget this year of about $10 million); b) the potential for a CGIAR System where some centres would move more toward a regional agro-ecological mode; and c) the interest of some in seeing a more decentralized, regional approach to forestry research within the system with separation of forestry and agroforestry research. The options are summarized in Table 10.5. The details of the models are shown in Annex VI. A comparison of estimated orders of magnitude for capital and operating costs are shown in Table 10.6.

Table 10.5. Alternative central mechanism(s) for dealing with the global elements of the proposed CGIAR forestry and agroforestry research initiative.

OPTION A	OPTION B	OPTION C	OPTION D	OPTION E
An Integrated Forestry/Agroforestry Research Centre	Separate ICRAF and a Global Forestry Centre	Three Regional Hands-on Forestry Research Centres with No Global Centre	Three regional, agroecological research centres (RARCs)	A Global Centre with No Hands-on Research function (the IUFRO/SPDC Model)
This model provides the TAC's view of the (global) research centre needed to support the proposed regional programme, starting with a clean slate approach.	This model takes ICRAF as laid out in its "Strategy to 2000" and then develops a separate central forestry mechanism that would deal with all other suggested topics.	This model is one that was considered by the earlier TAC Forestry Panel. It envisions two sub-options: one includes the establishment of at least three regional forestry centres, with agroforestry being handled separately by the existing IARCs and ICRAF.	Three regional, agroecological research centres (RARCs) building on existing IARCs (e.g., CIAT, IITA, ICRISAT) with no global forestry or agroforestry centres.	This IUFRO/SPDC model consists essentially of a central council mechanism that would act as a broker, a facilitator for creation of networks, and a central training and data base point for forestry. It is assumed that agroforestry would continue to be handled by the IARCs and ICRAF. It would be similar to the Tropical Forest Research Council recommended by the Bellagio Forestry Research Force.

Table 10.6. Summarized comparison of the capital and operating costs of various institutional options for incorporation of forestry and agroforestry into the CGIAR System

Option	Capital Cost (US$ million)	Annual Operating Costs (US$ million)
"A" - An integrated forestry/agroforestry centre as recommended by TAC	20	25
"B" - Separate agroforestry and forestry centres (leaving ICRAF as placed and adding a separate forestry research centre (a) ICRAF as is planned by 1995 (b) Separate forestry research centre	 5 15	 25 16
Total cost of Option B	20	41
"C" - ICRAF as planned by 1995 plus three separate forestry research centres (a) ICRAF as planned by 1995 (b) Three regional forestry reserach centres (no centralized forestry centre)	 5 45	 25 33
Total cost of Option C	50	58
"D" - Three regional agroecological research centres (no ICRAF and no centralized forestry research centre). Total Cost of Option D	15	40
"E" (a) ICRAF as planned by 1995 (b) A small International Forestry Research Council with no hands-on research function (the IUFRO/SPDC model)	 5 (-)	 25 25 ($5 million core and $20 million contractual research
Total cost of Option E	5	50

10.6. TAC's Evaluation of Institutional Options for the Central Mechanism

The previous section (and Annex VI) described briefly five different institutional options for the central mechanism(s) for guiding the overall TAC recommended CGIAR initiative in forestry and agroforestry. In the present section the relative merits of the different models are assessed and the reasoning behind TAC's decision to recommend Option A (the integrated forestry/ agroforestry model) is indicated.

Two basic points should be kept in mind when reviewing TAC's assessment of the models:

- For each model, there is an almost infinite number of permutations in terms of size, staffing, growth pattern, etc. TAC has attempted to define five generically different options for achieving the objectives set (related to subject coverage, geographical distribution, and relationship to ongoing and planned activity). For the many reasons suggested in the text, the models are only illustrative of the possibilities for each option, as are the budget estimates. The details will be defined in the implementation phase, once the CGIAR has decided on the basic model it prefers to follow;

- TAC recognizes full well that whatever option is chosen, it will involve an evolutionary process, starting small and growing larger as progress is made; the numbers provided are targeted for 1995. However, it is fully recognized that actual growth for any given model might vary considerably from the assumed pattern.

10.6.1. Evaluation Criteria and Considerations

In evaluating the different institutional options for the centralized mechanism(s), TAC developed a set of criteria which were derived from a) the general conditions and trends in world forestry discussed in Section 10.1.1; b) the premises and assumptions discussed in Section 10.1.5; c) the basic conditions for sound science and solid research which have been the cornerstones of CGIAR success in the past; and d) the criteria used previously by TAC in evaluating the institutional options for forestry.[1]

The criteria and considerations developed include the following (not listed in any order of priority):

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[1] See "Institutional options for entry of forestry into the CG system." TAC Forestry Panel, Phase III, March, 1990.

1. **Consistency with general development trends in forestry**
   - is the option consistent with TFAP, Bellagio, and general trends in Official Development Assistance?
   - is the option consistent with the general trend toward integration of fields dealing with land use?

2. **Coverage of priority issues, i.e. relevance**
   - does the option deal as effectively as possible with the priority problems that exist, such as containing deforestation?
   - does the option adequately consider equity and gender issues?
   - what is the likelihood of achieving early research results that will affect a large number of developing country persons?

3. **Scientific quality and integrity**
   - does the option involve hands-on research?
   - how easy will it be to achieve and maintain high scientific standards?

4. **Flexibility in light of an evolving CGIAR structure**
   - what is the relative flexibility in terms of being adjusted to, for example, a system based on ecoregional centres?

5. **Involvement with, and contribution to existing national or regional research institutions**
   - how well can the various options deal with national and regional research institutions? What are the main contributions which the centre(s) can make?

6. **Involvement of existing CGIAR centres**
   - which options are particularly tuned in to cooperation and involvement with the existing centres?
   - what mechanisms can be introduced easily to insure coordination among organizations and programmes?

7. **Giving a clear identity and focus to CGIAR forestry and agroforestry research**

8. **Avoiding disruption of ongoing activity and programmes**

9. **Contribution to training developing country researchers**
   - how do different options compare in terms of training researchers and providing support for them through self-learning activities, technical guidance, and advisory services?

10. **Cost considerations**
    - which is most cost effective and efficient?
    - what are the relative investment costs of the options?

10.6.2. TAC's Assessment of the Options

Table 10.7. summarizes TAC's assessment of the models or options for the centralized mechanism(s) that would drive the recommended overall strategy and plan for forestry and agroforestry in the CGIAR System. TAC concludes that Option A, an integrated forestry/agroforestry centre would be the most appropriate central mechanism to coordinate and guide the overall CGIAR initiative in forestry and agroforestry. The budgetary implications of Option A are set out in Annex VII.

TAC also concludes that ICRAF, with modifications to its mandate, programme and structure, could become the recommended centre, provided that ICRAF's Board and Management[1]:

a) Adopt a revised mandate that incorporates the areas of research included in the recommended CGIAR research agenda;

b) Are willing to accept a change in name which reflects the broadened mandate; and

c) Prepare, in consultation with TAC, a revised strategic plan, a medium-term plan, and an organizational plan that would then be subject to the normal CGIAR procedures.

In the event that ICRAF is not interested in taking on the role indicated above, the CGIAR should take steps to establish a new integrated forestry/agroforestry centre to spearhead the four-pronged approach.

10.7. Strengthening National Research Capability to Work with and Benefit from CGIAR Supported Research Activities

Earlier TAC discussions have focused on the need for improved institutional and financing mechanisms that would a) provide a more systematic framework for mobilizing technical assistance for strengthening of national research capability and b) relieve the CGIAR of the financial burden of what is essentially technical assistance rather than research activity.

The key elements of an improved financial and institutional mechanism are considered to be:

a) An increased level of untied multilateral funding that could be mobilized rapidly in support of CGIAR networks that require a significant input of enabling assistance;

b) An institutional mechanism that could identify the staffing and resource needs of such networks and then assure that these needs are systematically brought to the attention of donors, e.g. during Centres Week;

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[1] See Annex VIII for details on an informal dialogue with ICRAF representatives and donors.

Table 10.7. Relative merits of alternative central institutional mechanism(s) for the proposed CGIAR forestry and agroforestry research initiative.

OPTIONS / CRITERIA	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E
	Integrated Forestry/Agroforestry Research Centre	Separate ICRAF and a Global Forestry Centre	Three Regional Hands-on Forestry Research Centres with No Global Centre; ICRAF remains	(At least) Three Ecoregional Research Centres Focussing on Ecosystem Issues	A Global Centre with No Hands-on Research Function (the IUFRO/SPDC Model)
1. CONSISTENCY WITH GENERAL DEVELOPMENT TRENDS IN FORESTRY	Good, since it fits the direction in which many developing country national government forest policies and ODA support for forestry is going, i.e. towards integration of forestry and agriculture and the role of trees in land use strategies;	Less favourable than A, because forestry development is moving more towards closer integration with agriculture; this model would require strong integration and coordination mechanisms; the need for a multi-disciplinary approach to both agroforestry and forestry research planning implies considerable duplication in staff structure and research agendas;	Same as for B, but good in terms of giving more balanced focus to regional forestry issues;	This option would have the advantages of A, but with more balanced regional sensititivity than A; it would more effectively integrate forestry and agroforestry with other areas of resource management (soil, water, etc.);	Least effective, since (a) it would not be an integrated model and (b) it would have no central capacity to do strategic research related to main issues and their definition;
2. COVERAGE OF PRIORITY ISSUES, i.e., RELEVANCE (e.g., containing deforestation; poverty alleviation; food and energy security; employment creation)	Good - e.g., deforestation is a problem which requires an integrated approach involvign agric./ agrofrest/forestry. Same is the case with most other key forest related issues;	Less favourable than A. There would be need for substantial coordination mechanism to avoid overlap in the case of most priority issue areas;	Same problem as with model B, although sensitivity to regional problems would be better;	This option would have the advantages of model A, but with more regional sensitivity and improved integration with other areas of research management;	Same as for item E above;
3. SCIENTIFIC QUALITY AND INTEGRITY OF PROGRAMMES	Would require tight supervision and controls to avoid breadth at the expense of depth; contribution could be signficant in terms of new breakthroughs;	Potentially more focused than A; however, this model would require control and supervision of two centres rather than just one; contributions could be as great as in the case of A;	Same as for B, but even more centres in which scientific quality and integrity would need to be monitored and controlled;	Same as for A, although there would be more centres requiring control and supervision;	Most difficult to control scientific quality, since this would be the most diffuse of the models, and there would be non hands-on research as a basis for developing standards of control;

Table 10.7. continued

OPTIONS / CRITERIA	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E
	Integrated Forestry/Agroforestry Research Centre	Separate ICRAF and a Global Forestry Centre	At Least Three Regional Hands-on Forestry Research Centres with No Global Centre; ICRAF remains	At Least Three Regional, Agroecological Research Centres (RARCs)	A Global Centre with No Hands-on Research Function (The IUFRO/SPDC Model)
4. FLEXIBILITY IN TERMS OF EVOLVING CGIAR STRUCTURE TOWARD, FOR EXAMPLE, ECOREGIONAL CENTRES	Relatively good flexibility; it actually could evolve into an ecoregional centre, if that is the way the System goes;	Less flexible than A, since there would be two centres with narrow and specialized mandates;	Somewhat better than B, since some thought would already have been given to regional ecosystems in these centres;	This model would be most flexible, since it already would have been oriented toward ecosystems approaches;	Quite flexible and adaptable, since there would be only a minimum central facility and structure which would need adjustment or incorporation into new centres;
5. INVOLVEMENT WITH AND CONTRIBUTION TO NATIONAL AND REGIONAL PROGRAMMES	Since much of the ongoing work is done through integrated programmes (e.g. Asian and CATIE MPTS Networks), this model would fit well with existing national and regional programmes;	This model could encounter problems of coordination in dealing with reg./nat. programs, e.g., which of the two centres would deal with Asian MPTS network, with CATIE Madelena project, etc.? It might be stronger in agroforestry in terms of the countries involved in ICRAF networks;	Would be good in terms of being on the ground in the regions; this model would still suffer from the inherent problems of a separation between forestry and agroforestry. Such a separation does not exist in many regional and national programmes that are now dealing with social forestry;	This would be a good model in terms of working with national institutions involved with "trees in land use" research;	Since the total focus of this programme would be on the regions and national programmes, this model would rate high in terms of interaction. However, the lack of hands-on research would limit its effectiveness in terms of working with NFR's on strategic research issues;
6. INVOLVEMENT WITH EXISTING CGIAR CENTRES	Would depend on programming details; could be strong or weak depending on contacts made and agreements reached;	Should be about the same as model A in terms of effective interaction with existing centres; would be less flexible if the System moves more towards ecoregional centres;	Should be positive, since the centres would already be regional and somewhat more oriented towards ecosystem and land use issues addressed by existing centres;	More or less the same as for C;	Probably very little interaction, other than through workshops and through possible contractual work with CGIAR centres;

Table 10.7. continued

OPTIONS CRITERIA	OPTION A Integrated Forestry/ Agroforestry Research Centre	OPTION B Separate ICRAF and a Global Forestry Centre	OPTION C At Least Three Regional Hands-on Forestry Research Centres with No Global Centre; ICRAF remains	OPTION D At Least Three Regional, Agroecological Research Centres (RARCs)	OPTION E A Global Centre with No Hands-on Research Function (the IUFRO/SPDC Model)
7. GIVING A CLEAR IDENTITY TO CGIAR FORESTRY AND AGROFORESTRY	Good, if one agrees that the integrated approach to forestry/agroforestry is the way to go;	Good if one thinks that the separation of agroforestry from forestry model is the appropriate way to go; (TAC does not think this is the case:;	Would be less favourable from a global perspective, but would provide clearer focus to forestry at the regional level, if one believes that separation of forestry and agroforestry is the right thing to do;	Good, if one believes that the integration of forestry and agroforestry is the right way to go;	It would provide a weaker image and focus, since the ;central unit would be relatively small and would not be directly involved with research and identifiable CGIAR System achievements;
8. DISRUPTION OF ON-GOING ACTIVITY AND PROGRAMMES	The model does not consider ongoing activities and programmes other than those of the existing CGIAR centres; if ICRAF is considered, safeguards would be needed to avoid serious disruption of ICRAF's ongoing agroforestry programmes;	No disruption to ICRAF and its strategy for the future; there could be some local disruption or change required, depending on where the new forestry centre would be located;	Should be minimal disruption, although there might be some local changes needed where the regional centres were located;	Same as for C; however, could be significant disruption for some of the existing centres involved;	Least disruption, since there would be no hands-on research, and the programme basically would be oriented towards using on-going national and regional programmes;
9. CONTRIBUTION TO TRAINING OF DEVELOPING COUNTRY RESEARCHERS AND MANAGERS	Depends on programming (same for all models); however, this model would make managers and researchers sensitive to the evolving trend towards research on integrated land use management rather than artificial separation, e.g. between forestry and agroforestry;	This model would be good if one accepts the desirability of a separation of forestry from agroforestry; it would be not so good if one accepts the trend towards integration and a more holistic approach to land management and research related to such;	About the same as for model B, although more regional sensitivity would be introduced into training activity;	About the same as model A, although it would be better in the sense that regional sensitivities would be introduced;	The major shortcoming here would be the lack of hands-on research to use as demonstration in training programmes; this problem could be overcome by using contracted personnel who actually are involved with hands-on research and research management;

c) A mechanism that would leave flexibility for bilateral donors either to contribute to such activity through a centralized mechanism or continue bilaterally to support individual research institutions should they so wish.

10.8. Next Steps: TAC's Recommendations

This section summarizes TAC's assessment of institutional strategies for incorporation of forestry and agroforestry into the CGIAR System.

The main conclusion of the report is that the most effective way of dealing with priority forestry and "trees in land use" issues of concern within the CGIAR mandate and goals is to develop an integrated forestry/agroforestry approach. Such an approach would be more effective in addressing the underlying causes of tropical deforestation than establishing separate forestry and agroforestry centres, since the problems associated with deforestation can only be addressed effectively with an approach that involves close interaction between agriculture, agroforestry and forestry. The proposed approach would make a significant contribution to most of the research areas needed to underpin the Tropical Forest Action Plan, as identified by the Bellagio Task Force on Forestry Research.

The four pronged approach recommended by TAC gives strong emphasis to support for meeting regional/national research needs through 1) a coherent plan to build on the capability of exisiting CGIAR centres, and 2) contractual and collaborative work with research institutions at the national and regional levels. At the global level, the recommended approach includes 3) incorporation of forestry/agroforestry activities into the mandates of IBPGR, IFPRI and ISNAR; and 4) an integrated forestry/agroforestry centre with strategic research capability that would provide a central focal point for forestry and agroforestry research activities (see Table 10.3).

In sum, based on its analysis and evaluation of research needs, existing institutions, and options for the future, TAC recommends that:

1) The CGIAR should support a four pronged institutional approach for forestry and agroforestry research, as set out above. TAC envisions a decentralized approach under which about 70 percent of resources would go to regional and national research and 30 percent to centralized activity.

2) For the centralized activity within the recommended approach, the CGIAR should support establishment of an integrated forestry/agroforestry centre. It would build on the organizational structure and research agenda summarized in the text. This model provides TAC's view of the extent to which the CGIAR System can address the

forestry/agroforestry topics recommended as priorities for research by the Bellagio Task Force on Forestry Research.

3) ICRAF could become the recommended centre, providing that its Board and Management:

   a) adopt a revised mandate that incorporates the areas of research included in the recommended CGIAR research agenda;

   b) are willing to accept a change in name which reflects the broadened mandate; and

   c) prepare, in consultation with TAC, a revised strategic plan, a medium-term plan, and an organizational plan that then would be subject to the normal CGIAR procedures.

4) In the event that ICRAF is not interested in taking on the role indicated in 3) above, the CGIAR should take steps to establish a new integrated forestry/agroforestry centre to spearhead the overall four-pronged approach mentioned in 1) above.

5) Existing CGIAR centres should begin planning, where relevant, for activities in forestry/agroforestry in concert with the overall CGIAR agenda in this area.

6) Parallel to the above initiative interested donors should consider expanding existing mechanisms for financing and implementing technical assistance activities (outside the CGIAR System) to support development and strengthening of national institutions involved in CGIAR sponsored research networks.

7) The CGIAR System should work closely and coordinate with other groups involved in supporting and carrying out forestry research to ensure that priority research on non-CGIAR supported topics are given adequate attention and funding.

CHAPTER 11 - IMPLICATIONS OF TAC RECOMMENDATIONS FOR CGIAR STRUCTURE AND RESOURCE NEEDS

11.1. Introduction

All of the component parts of TAC's analysis have now been presented. Beginning with long-run global and regional challenges, TAC has underlined the magnitude of the task of feeding a rapidly expanding, more urbanized population, while using sustainable production systems. TAC then evaluated the evolution of the CGIAR and proposed a restating of the mission and goals to reflect broadened interests. TAC began its analysis of the specific tasks given it by sketching possible long- and medium-term visions against which to make shorter-term decisions. TAC has disclosed its specific analysis of the relevant subject matter areas and the non-associated centres embedded in them and has made a comprehensive proposal for the incorporation of an integrated forestry/ agroforestry initiative.

All of the components of the recommendations have significant implications for the overall structure of the CGIAR, the mandates of existing CGIAR centres as well as the mandates of those recommended for admission. Finally, the recommendations clearly have implications for the financial resources needed for an expanded CGIAR. It is the task of this final chapter to address these issues. It begins with a summary review of all the implications of TAC's recommendations. It then presents a possible evolutionary path for the CGIAR which is followed by a general discussion of possible options for restructuring. The chapter concludes with two scenarios about future funding needs.

The fundamental question to be addressed in the analysis is; given the needs and the long- and medium-term visions, can the CGIAR get from where it is now to where these visions suggest. The CGIAR must recognize the value of what is and seek to preserve and enhance those elements which are critical in the proposed future and be realistic in proposing changes that minimize immediate dislocation and costs. The process selected must be evolutionary, giving due consideration to humane adjustment, even though the long-run outcome may be quite revolutionary compared to the present.

11.2. Main Conclusions of TAC's Analysis in Summary

At this juncture it is worthwhile to place in summary the totality of TAC's recommendations.

First TAC has recommended an explicit broadening of the CGIAR's mission and goals to include sustainability, natural resource management and food self-reliance. These changes move the CGIAR away from a self-imposed limitation to food crops and an implicit commitment to national food self-sufficiency.

Second, TAC has proposed a sharper delineation between the types of activities and mechanisms the CGIAR supports in its medium term. Two basic types are proposed:

(i) ecoregional mechanisms charged with developing a comprehensive understanding of their agroecological zones, that is the soil, water and plant processes characterizing these and the impact of human decisions on their utilization and pursuing applied and strategic work on selected commodities - crop, trees and livestock - of particular importance to the ecoregion; and,

(ii) global mechanisms pursuing either highly focused germplasm-based commodity research mainly at the strategic level or pursuing strategic research on selected subject matters such as policy and management of transnational and global significance.

Third, TAC is recommending expanded commodity and subject-matter coverage by adding:

- trees, including a modest effort in coconut
- vegetables
- banana and plantain
- fish
- irrigation management

Fourth, TAC is recommending changing emphasis in existing institutes in the following areas:

- pursuing all research with a long-run sustainability perspective;

- expanded efforts in natural resource management and conservation in an integrated interdisciplinary fashion thereby strengthening work in soils-water-plant nutrients in existing resource management programmes;

- the explicit integration of forestry and agroforestry activities into ecoregional centres;

- expanded efforts in pest and disease management in all commmodity and ecoregional centres;

- rigorous review of bilateral and adaptive and applied research activities to determine those better done by national partners and transnational collaborative mechanisms.

Fifth, TAC has made explicit statements designed to focus CGIAR activities in recognition of its selective and relatively small role on the global agricultural scene. These include:

- a clearer statement of the CGIAR role in strengthening national programmes;

- a caution against the CGIAR using its institutes as development agencies, while at the same time recognizing the critical role of development assistance to the CGIAR accomplishing its goal.

- a reaffirmation of the CGIAR's long term special advantage in research issues of an increasingly strategic nature of global or transnational importance;

- an identification of a more limited set of activities for which there will be long-term needs, e.g. germplasm and strategic resource management research and in which the CGIAR would play a continuing role.

11.3. A Possible Evolutionary Path: Generic Principles and First Steps

11.3.1. Some Principles

As the CGIAR moves towards the medium- and long-term it should organize itself in a way that will ensure building on present strengths, address its present weaknesses, prepare itself for best fulfilling its long-term goal and effectively carrying out its short and medium term missions. To accomplish these ends the CGIAR must recognize its limitations and not try to be all things to all people.

Clearly, the biggest challenge facing the international development community in the medium term is to work with national partners in developing countries to strengthen national research programmes and transnational mechanisms of scientific collaboration. Success in these efforts is an absolute prerequisite to CGIAR success. But the CGIAR is not well equipped to be the lead or even dominant agency in this task. Certainly, the proposed ecoregional mechanisms, by assuming prime responsibility for national programme interfaces, can help at the scientific level but needs for technical assistance, infrastructure development, revised policy and financial resources must come from efforts at a much more aggregate or macro level. But, to repeat, the TAC medium- and long-term visions depend on the improvement of national programme capacity.

As the CGIAR undertakes consideration of restructuring, it should attempt to correct past weaknesses. In TAC's judgement a sharper delineation of responsibilities between global and ecoregional mechanisms should help:

- rationalize overlapping commodity mandates;
- remove overlapping resource management activities;
- fill gaps in resource management coverage and strengthen areas of weakness;
- delineate clear global responsibilities for strategic research on resource management concerns;
- provide clear focal points for coordinating decentralized activities in many commodities;
- reduce the difficulties of national programmes in dealing with a multiplicity of commodity institutes;
- ensure better coordination of the CGIAR strengthening efforts and donor technical areas and programmes.

11.3.2. First Steps

(i) If the CGIAR accepts TAC's recommendations or at least most of them, it must begin immediately to accelerate the already emerging trend toward expanded resource management research in ecoregional mechanisms. For these efforts to be comprehensive and provide a mechanism for new efforts in forestry and agroforestry, CGIAR efforts will have to be expanded to ensure that major ecoregions are covered in a systematic way. TAC recommends considerable pragmatism in this regard. TAC is not necessarily recommending separate institutes for each major ecoregion but rather suggests exploring modifications of existing institutes and searching for alternative mechanisms of linking strong national programmes or using existing mechanisms of transnational collaboration. The essential thing is that there be a reasonably comprehensive coverage of the major ecoregions which contribute significantly to global food needs. In the medium-term these institutes would have primary responsibilities for interacting with national programmes.

TAC's view is that in the medium term these ecoregional mechanisms would move towards sharing more of their responsibilities with national programmes and a variety of mechanisms of transnational collaboration at the technical level. In the long run, the necessity for physical international institutes per se should diminish and may disappear if the desired strengthening of national programmes and transnational collaborative mechanisms occurs. What would remain in the long run would be the need for continuous attention to transnational and global strategic research on the ecological foundations of sustainable production systems.

(ii) Existing CGIAR commodity institutes would move towards a more sharply defined research programme using germplasm improvement as the organizing principle. Research would be of a more strategic nature using modern biotechnology as well as more traditional techniques. TAC does not see these more sharply focused activities being centralized at a single location. Rather TAC sees exciting possibilities of a relatively small headquarters staff with strong delegation of authority to small teams in ecoregional centres. As these global commodity institutes evolve, it will be necessary to address explicitly the division of responsibilities between them and the CGIAR global activities in germplasm collection, conservation, preservation and the maintenance of biodiversity (currently the IBPGR role). TAC sees several possible models that could be explored but leaves that discussion to a later stage.

(iii) As new commodities and subject matters enter the CGIAR, every effort should be taken to ensure that the new strategic plans and proposed programmes of work are consistent with what TAC sees as the emerging CGIAR model. The TAC proposals on forestry and agroforestry can serve as a prototype since these recommendations are premised on the notions of ecoregional institutes collaborating effectively both with the centralized mechanism and with national programmes. Similar attention should be paid to vegetables, banana and plantain and fisheries. As these entities respond to TAC's recommendation, the CGIAR should encourage them to develop in a collaborative integrative fashion.

Similarly, activities in irrigation management should be developed with an aim at fostering appropriate linkages to institutes doing biological work in irrigated ecosystems as well as those institutes in management and policy.

In listing these tentative first steps TAC is pleading for the Group to proceed with whatever expansion it deems appropriate in a holistic rather than piece meal fashion. The remodelled CGIAR, as TAC sees it, requires adjustment both of existing as well as new institutions. When the CGIAR's decisions are taken it will be necessary to pursue with more precision exactly how the short-term evolution will occur. Here TAC has stated what it sees as necessary first steps and some basic principles.

11.4. Some Institutional Possibilities in the Transition Period

11.4.1. Approach and Guiding Principles

TAC would have preferred to have stopped at general principles of restructuring and not proceeded to talk of existing institutions. However, CGIAR donors have every right to ask whether the restructuring is feasible and whether it would be destructive to existing quality institutions. Therefore, in this section TAC presents some possible institutional adjustment scenarios that seem worthy of exploration. Recognizing the sensitivities of existing Centre Boards, management and staff personnel to discussions of altered roles, TAC underlines that these are presented as plausible options to be debated, not recommendations for immediate change. Also, it should be kept in mind that TAC currently is in the process of completing a major revision of CGIAR priorities and strategies. This revision, to be presented to the Group at ICW 91, will be invaluable in guiding relative emphasis among commodities, ecoregions and subject matter areas. Therefore the discussion that follows is conditional.

In approaching this delicate task, TAC debated three possible ways of proceeding. In each case TAC was using the medium- and long-term visions as desired end points. The first possible approach is the so-called "clean slate" approach where one begins by asking if the CGIAR was to start afresh with US$ 250 million and the medium-term vision, how would it be structured. A second approach would be to start where the CGIAR is now and suggest only the minimum necessary changes to accomplish the inclusion of the specific new activities. A third would be an intermediate approach which considered the possibility of considerable restructuring but uses existing institutes as the beginning pieces of the puzzle. This could be called the pragmatic approach based on certain principles.

TAC adopted the last approach and was guided by the following operating principles:

(i) wherever possible build on what exists that is of quality and efficiently operated;

(ii) keep firmly in mind the medium-term vision and the objective of more clearly delineating responsibilities for activities and reducing the potential for conflict and confusion;

(iii) clearly distinguish between an activity and an institution. TAC is pressing for clear responsibilities for activities but sees no particular reason that an institution could not operate two activities, one global and one ecoregional. The guiding principle should be that each has clear priorities and that one

does not dominate the other, either intellectually, or in terms of resource availability;

(iv) an institution is an organizational form with governance, management and operational functions. Except for governance, there can be varying degrees of decentralization, both of decisions and the geographic location, of the other two functions. Thus when TAC talks of a particular institution having a particular responsibility it does not imply that all of its activities are at one physical location, in one geographic location;

(v) there are available forms of decentralization that make possible managing highly variable numbers of scientists. However, two considerations were kept in mind. One was the need for a critical mass for effective pursuit of particular research projects and the other was possible diseconomies of very large congregations at single sites;

(vi) scientists at all levels must have the possibility of collaborating directly or indirectly with the ultimate partners, the national programmes, and they must also have the possibilities of necessary discipline and basic research linkages globally. The global centres must not become basic research enclaves isolated from applied and adaptive problems. Nor can the ecoregional entities become provincial islands isolated from modern science. Fostering effective collaboration is a key to the future success of the CGIAR.

11.4.2. Some Possible Scenarios

TAC began with two basic vectors - ecoregions and commodity groups (Section 8.5.) and asked how could the CGIAR cover those considered important in the medium term. It took existing institutions - CGIAR and non-associated - as the beginning available institutional forms. The possible options fall out from the degree of activity purity adopted (i.e. pure ecoregional institutes) on one extreme versus institutional pragmatism on the other.

Beginning with major ecoregions, TAC asked how could the fundamental needs of the following be met: understanding the basic physical and biological processes of the ecoregion; understanding the nature of the land-use continuum and how crops, trees and animals interact in their physical, biological and social environment; and doing research on major commodity-based farming systems in collaboration with global commodity activities. In many cases expanded decentralized CGIAR efforts in forestry and agroforestry would be in ecoregional institutes.

11.4.2.1. Ecoregional Research

(a) Latin America

In Latin America there are three existing institutes, none of which have explicit ecoregional programmes. CIAT was originally conceived as an ecoregional institute but evolved to a global and regional commodity institute. Thus, one could think of several

possibilities, each of which would be conditioned by which commodity responsibilities were assigned to various institutes. Towards the purity extreme, one could think of moving CIAT towards an ecoregional institute for the humid and subhumid warm tropics and subtropics (summer rainfall) of Latin America. At a later stage the semi-arid areas of warm tropics and subtropics might be added. The mandate would be very large and clearly CIAT would have to de-emphasize some or all of its commodity germplasm work. One option, moving more in the direction of pragmatism, would be for CIAT to have these ecoregional responsibilities but outpost its staff for the cool tropics and subtropics at CIP and those for the semi-arid tropics and subtropics at CIMMYT. A third more decentralized option would be to assign CIP and CIMMYT, in addition to their commodity mandates, responsibilities for the ecoregion in which they are located. A more radical option could be to consider combining CIAT and CIP to provide comprehensive coverage of most of Latin America with the combined, but decentralized institute, also having global commodity responsibilities for roots and tubers.

(b) Sub-Saharan Africa

In sub-Saharan Africa, IITA is the closest to TAC's notion of an ecoregional institute. With minor modifications to its mandate IITA could serve as the ecoregional centre for the humid tropics of Africa. If IITA divested itself of its only current global commodity responsibility, cowpeas, it might also expand to undertake responsibility on an Africa-wide basis for both the humid and subhumid warm tropics. In addition, TAC has recommended that IITA take global germplasm responsibility for banana and plantain.

The semi-arid warm tropics of Africa are currently the province of the African programme of ICRISAT. This work is expanding and ICRISAT also carries global commodity responsibilities. One possible scenario, in keeping with TAC's notion of an ecoregional institute, would be to make the Africa ICRISAT programme a separate institute. If this were to occur, an alternative to IITA assuming responsibility for the subhumid warm tropics would be to assign that role to this new institute built from the ICRISAT Africa programme. This institute could also undertake selective work in the cooler, higher elevation areas. It seems to TAC that two institutes could reasonably cover the major ecoregions of sub-Saharan Africa.

But the discussion of this region cannot end without mention of the livestock activities and the rice work of WARDA. At issue in livestock is the herbage and fodder work at ILCA. This has considerable commonality with current programmes of both IITA and ICRISAT and could therefore be integrated into these programmes. However, as this would separate the animal from its feed source and its environment, other alternatives are discussed later under the discussion of a global activity in livestock. WARDA remains in the emerging thinking of TAC as somewhat of an anomaly as it always has been. It is a regional, single commodity centre. For the future it does not easily fit either the global commodity or the ecoregional model. Therefore, to retain WARDA as a regional commodity institute would require additional consideration and rationale. Alternative possibilities would be to merge WARDA with IITA, an attractive possibility particularly if IITA takes on the ecoregional responsibility for the subhumid warm tropics. WARDA then would become a decentralized location for a range of programmes. The

other obvious possibility, often debated before, would be to merge WARDA with the global rice commodity activity.

TAC recognizes the past debate about WARDA and in no way is questioning the Group's past decisions nor is it casting aspersions on what is emerging in WARDA as a well thought out programme. It is raising the issue because in the comprehensive way TAC is looking at possible future scenarios, it would be irresponsible not to raise the issue.

(c) West Asia and North Africa (WANA)

The West Asia and North Africa region is largely an arid and semi-arid ecoregion in the subtropics (winter rainfall). ICARDA's present programme is addressing the semi-arid region. The emerging programme at ICARDA has many characteristics of TAC's vision of an ecoregional institute. Necessary adjustments would be to relieve ICARDA of any global commodity responsibilities (barley) and to add activities in forestry and agroforestry. Further discussions of possible ICARDA work is deferred until the discussion of global institutes.

(d) Asia

The rest of Asia is large, heavily populated and ecologically very diverse. It also contains relatively few countries, some with strong national programmes. These characteristics are cited because the possibilities for Asia are limitless and only a few pragmatic ones are presented. Tropical and subtropical (summer rainfall) Asia contains humid, subhumid and semi-arid moisture regimes. There are also wide variations in temperature. Further, in Asia, irrigated agriculture makes a greater contribution to global food output than in any other developing country region.

ICRISAT Centre is currently the only centre in Asia with ecoregional responsibilities limited to the semi-arid warm tropics of Asia. One scenario would be to add the subhumid warm tropics and the semi-arid/subhumid warm subtropics to ICRISAT's mandate. The institute could also undertake selective work in cooler, higher elevation areas. Parallel with this option, one could consider assigning explicitly to IRRI responsibilities for irrigated ecosystems in Asia and WANA, as well as the humid warm tropics and subtropics in Asia. This would be a large mandated area for IRRI. However, given the strengths of several large national programmes, its activities could be largely at the strategic level of transnational importance. In this option, a merger of IIMI into IRRI would be worthy of some consideration.

An additional alternative would be to judge national programmes sufficiently strong in ecoregional type research, such that coverage could be done through networks or other mechanisms of transnational collaboration. It is not TAC's judgement that new ecoregional institutes should be created. Clearly any scenario involving Asia turns on the role of IRRI and ICRISAT, however remodelled in global commodity strategic research.

11.4.2.2. Global Responsibilities

(a) Annual Plants

If the CGIAR moves towards more sharply focused germplasm/commodity institutes, four groupings of commodities could be considered: cereals, roots and tubers, legumes and vegetables. Several scenarios present themselves, recognizing throughout that decentralized commodity institutions are visualized with strong delegation of authority to small teams of outposted staff in ecoregional centres.

(i) Cereals. Certainly a first option to consider in cereals would be to leave the distribution of cereals responsibility as they are IRRI - rice, possibly merged with WARDA; CIMMYT - wheat and maize; ICARDA - barley; and ICRISAT - sorghum and millet. The rationale is the size of the needs in the three major cereals - rice, wheat and maize, and the absence of obvious economies of scale in combining rice with any of the others. A second possibility would be to leave rice with IRRI and merge wheat, maize, barley, triticale, millet and sorghum into CIMMYT. Using decentralized mechanisms, this option would clarify overlapping mandates and could offer some economies of scale. For completeness one could think in the very long term of a cereals institute, although TAC is not currently attracted to that concept.

(ii) Roots and tubers. Again, a status quo option can be considered - CIP as a highly focused potato and sweet potato institute, cassava in CIAT and yam at IITA, with the latter two carrying responsibilities for the global commodity in conjunction with ecoregional responsibilities. A second option mentioned earlier would be to combine CIAT and CIP, and make the combined institute the global institute for roots and tubers and the ecoregional institute for Latin America. A third option is to have CIP assume global responsibility for all roots and tubers in a decentralized mode. An additional interesting possibility could be to include banana and plantain in that mandate because of similarities in technical issues and scientific methods.

(iii) Legumes. Only a limited discussion is presented at this time because the ongoing review of CGIAR priorities and strategies will clearly be addressing the question of the relative priority the CGIAR should give to these crops. Currently, responsibilities are scattered: chickpea, pigeonpea and groundnut - ICRISAT; beans - CIAT; cowpea - IITA; and selected pulses - ICARDA. If there is to continue to be an effort in this area, in addition to the status quo, additional options could be explored, such as one global institute addressing all legumes; this could be ICRISAT. An alternative would be two institutions with continental responsibilities, e.g. Africa and Asia. Clearly, whatever option is further explored, it should address the diversity of species and ecoregions where these crops are grown in complex farming systems. In this regard a quite different option would be to embed whatever activities in legumes the CGIAR supports in selected institutes and not have a global commodity activity.

(iv) Vegetables. Selected vegetables are in the mandate of a candidate institution, AVRDC. TAC is recommending the admission

of a modified AVRDC with a global mandate and responsibility for a series of regional networks. In addition to this, the critical consideration would be the integration of vegetables into the work of appropriate ecoregional institutes. This would offer some alternatives regarding the role of the global institute at the regional level.

(b) Perennial Plants

(i) Trees. As indicated in Chapter 10, TAC is recommending the content and form of a major CGIAR initiative in forestry and agroforestry. Clearly there can be a productive global role for a forestry/agroforestry institute. However, TAC envisages it working more in terms of commonalities in ecosystems across regions and less in terms of commodities with global applications, though clearly attention would be paid to multipurpose trees. In fact, it is envisaged that the majority of forestry/agroforestry work will be done with strong emphasis on regional land use systems involving a significant tree component. Until this option is thoroughly debated, TAC prefers not to reopen previously discussed options (see Chapter 10).

(ii) Coconuts. TAC recommends the inclusion of a modest coconut programme in the forestry/agroforestry initiative with the close collaboration with IBPGR. After extensive debates, TAC found no other currently viable options.

(iii) Banana and Plantain. Several institutional options were outlined in Chapter 9 and are not repeated here. TAC's recommendation is to integrate INIBAP into IITA.

(c) Livestock

The CGIAR's current activities in livestock research are limited in terms of species (ruminants, mainly large), and geography (mostly Africa). Progress at ILRAD, particularly in theileriosis, suggests possible changes in ILRAD emphasis. Thus, broad strategic questions need to be addressed as to which species, regions and research topics need to be explored. As noted in Chapter 9, TAC has deferred a long-term recommendation on ITC pending the completion of the Winrock livestock study, TAC's priority exercise and the EPRs of ILRAD and ILCA. Suffice to say at this moment that the TAC Panel on livestock diseases in Africa concluded that there was a need for better coordination of current programmes and a more integrated approach to problem-solving research in the future. Not only did the Panel comment on the need to integrate work on the vector, the parasite and the host of a particular disease but that there also was need for greater collaboration between traditionally separate approaches to livestock disease control and livestock productivity improvement. Therefore TAC does not comment on specific possibilities for integration among current livestock-related programmes in ILRAD, ILCA, ITC, ICARDA and CIAT. These will be revisited at a later stage and reported to the CGIAR.

(d) Fisheries and Aquaculture

Currently there is no fisheries research work in the CGIAR. TAC is recommending CGIAR involvement in selected topics in fisheries and that ICLARM is recommended as a possible vehicle after appropriate planning and review. Thus, it is not appropriate to reopen options already discussed in Chapter 9.

(e) Policy and Management (Including Irrigation Management)

A central tenet in TAC's recommendations is that policy and management issues relevant at the ecoregional level would be elements of the mandates of ecoregional institutions. Remaining global, strategic and methodological issues would need to be addressed globally in both the medium and long term. In the transition period, as with other centres, several options are worthy of debate. The first is to continue the three institutions as separate entities. A further option, already noted, would be to integrate IIMI into an institution addressing issues in "irrigated ecosystems". Given the similarity in research approaches, closer collaboration if not integration might be explored for IFPRI and ISNAR. Alternatively, given common interests in the management of national systems, ISNAR and IIMI have potential commonalities. These and other options need to be fully debated as the CGIAR moves towards the medium term.

(f) Genetic Resources

Both the medium and long term visions see a CGIAR role in this subject matter area. Its exact form however will depend on the evolution of global commodity institutes and the division of responsibilities between them and IBPGR. It is premature now to proceed further on possible options.

11.4.3. The Need for Consistency

The purpose of this already long section was to identify possible ways the CGIAR could evolve structurally as it moves towards the 21st century. TAC has refrained from attempting to put together complete scenarios for the CGIAR. Rather, it has chosen to explore possible sub-options for ecoregional and global activities. Clearly not all combinations of such options are consistent. Following the Group's discussions and decisions on TAC's specific recommendations the discussion of future structure will need to be reopened.

11.5. Resource Implications

Finally, the CGIAR asked TAC to include financial resource implications in its analysis. As TAC's decisions emerged and the medium-term vision was presented, TAC asked the CGIAR Secretariat to assist in preparing an analysis of (1) the current situation; (2) the implications of the specific recommendations on non-associated centres and forestry and agroforestry; and (3) the medium-term scenario. That analysis concludes this chapter and TAC's report.

The preceding sections have described the main principles in developing the longer- and medium-term visions relevant to consideration of the expansion of the CGIAR programmes. In the following paragraphs financial implications of the expansion are presented in the shorter term and also in the context of the medium-term vision.

The fact that the CGIAR expansion includes existing institutions implies that, at least in the short term, additional funding will be required. As shown in Table 11.1, the entities proposed to be added to the CGIAR are estimated to be funded at a level of about $37 million in 1990. About 70% of this, $26.4 million, is estimated to be provided by the current donors to the CGIAR. The requirements for 1995, as estimated by these centres in most cases, are in the order of $99 million. Assuming that the current level of funding will continue, an additional $70-75 million or so will be needed by 1995 to support the expansion. This figure needs to be treated with some caution and with several caveats.

In the first instance, the 1995 estimates are largely centre estimates, i.e. TAC has not gone through the detailed programmes to assess the relevance of each and every activity as is normally done in the course of a review of centre's medium-term plans. The proposed conditionalities of joining the CGIAR in most cases make it difficult to prejudge the outcome of a systematic effort by the centre to prepare a strategic plan and a medium-term plan which is then reviewed by TAC. It is likely that this process of review will result in a different financial outcome including a lower scale than that currently envisaged by the centre.

Secondly, the financial estimates represent the total needs of the centre. Applying the current convention of describing programmes in two tiers (essential and desirable) will result in a better understanding of the financial magnitude relevant for "essential or core" programmes. The net result will not necessarily be smaller in terms of total funding needs, but will probably be smaller in terms of the "core" requirements. On the other hand, it is equally clear that these downward adjustments could be offset if the expansion entities turn out to have as yet unspecified requirements for capital items.

11.5.1. Existing Centres

In considering the expansion, the financial requirements of the existing CGIAR centres also need to be addressed. TAC does not believe that in the short term it would be reasonable to assume that funds being provided to the CGIAR centres to fully fund their approved programmes can be justifiably redirected to the expansion entities, although this, of course, will be subject to review over the next twelve months as part of the CGIAR priorities and strategies task described earlier. Meanwhile, an attempt has been made to provide indications of the requirements of the existing centres in 1995. These projections extrapolate the approved programmes of existing centres adjusted to reflect the downward adjustments in 1990. As indicated in Table 11.1, by 1995 an increase of $67 million over the 1990 level of $240 million is projected.

table 11.1

TABLE 11.1 INDICATIVE FUNDING NEEDS OF THE CGIAR
(current US$ millions)

Current CGAIR essential programmes
Existing centres 1/

	Revd. 1990 Funding	Positions	Projected 1995 Funding
CIAT	28.1	82	35.8
CIMMYT	27.1	83	37.4
CIP	16.4	73	20.2
IBPGR	7.1	30	8.0
ICARDA	22.0	60	29.1
ICRISAT	29.2	92	37.1
IFPRI	8.8	37	11.1
IITA	23.2	92	28.3
ILCA	20.2	64	27.6
ILRAD	13.5	58	17.2
IRRI	30.6	73	37.3
ISNAR	6.8	32	8.5
WARDA	6.4	24	9.8
Total essential programmes			
Senior positions		800	925
Funding (in $m)	239.4		307.3
Annual growth in funding			5.1%

Total programmes of expansion centres 2/

	Plans 1990 Funding	Positions	Proposed 1995 Funding
AVRDC	9.8	20	16
ICLARM	4.1	13	8
Forestry 3/	9.5	50	50
Coconut	0		3
IIMI	9.1	35	17
INIBAP	1.8	5	2
ITC	2.7	10	3
Total			
Senior positions		133	230
Funding (in $m)	37.0		99.0
Annual growth in funding			22%

Total current system and expansion		
Senior positions	933	1155
Funding (in $m)	276.4	406.3
Annual growth in funding		11%

CGIAR programes in the medium term

	Senior Positions
Global Centres	
Cereals	90 - 110
Roots and Tubers	40 - 50
Legumes	15 - 20
Vegetables	15 - 20
Trees	60 - 75
Livestock	60 - 75
Fish	30 - 40
Germplasm conservation	50 - 60
Policy and Management	60 - 70
Total	420 - 520
Ecoregional centres	
Africa 1:	70 - 80
Africa 2:	70 - 80
Asia 1:	70 - 80
Asia 2:	70 - 80
WANA	30 - 40
LAC	70 - 80
Total	380 - 440

Expanded CGIAR total	
Senior positions	800 - 960
Funding requirements	
in 1990 $m	239 - 287
in 2005 $m	431 - 517

1/ 1995 projections are extrapolated approved programmes reduced in proportion to approved vs. actual 1990 funding.
2/ Amounts and positions based on centre data if available otherwise estimated by CGIAR Secretariat.
3/ Includes ICRAF AND IUFRO/SPDC

11.5.2. Summary of Short-Term Requirements

Looking at the two together it is quite possible that to fully support the integrated CGIAR programmes including forestry will require additional funding of the order of $140 million by 1994/95. These requirements are justifiable if CGIAR programmes are to fully respond to the research challenges and the needs of its clients. On the other hand, the magnitude of the required funding increase, an annual rate of about 9% for the next several years, since it is higher than the 6-7% increase over the past decade, may prove to be an overambitious target.

11.5.3. Proposed Response

Depending on the response by the CGIAR to these proposals, TAC intends to proceed in the following way. In the first instance, the priorities and strategies exercise currently underway provides a vehicle to systematically reassess the relative priorities among the existing and proposed activities. Having made the decisions on the specifics of the expansion, it should be possible to derive future short-term options based on the CGIAR guidance regarding future availability of funding.

In addition, to provide a context for the short-term needs, the following section also sketches out the resource implications of the medium-term vision of the CGIAR. A single scenario corresponding to the structural adjustments described earlier in this chapter is shown in Table 11.1. The main conclusion is that, if the overall principles in the medium-term vision hold, it would be feasible to operate responsive and integrated CGIAR programmes in the first decade of the next century requiring no more resources than those provided in 1990.

11.6. Resource Requirements in the Medium-Term Vision

In developing tentative budget estimates for the medium term, TAC was assisted by the staff of the two Secretariats in developing general notions of staffing patterns at the global and ecoregional institutes. They are presented as illustrative examples, not as firm statements of requirements.

11.6.1. Global Commodity Centre Model

Conceptually a typical global commodity centre would be expected to undertake research and related activities in germplasm conservation, characterization, evaluation (general and specific) and enhancement. The centre would also need to have in-house capacity for the study of major pests, diseases and stresses that affect the productivity of the crop.

At the very minimum a centre with a global commodity mandate would need to have capability in germplasm conservation and characterization. This would imply having 1-2 senior staff - a curator and a documentation specialist for a major crop; and at least one senior staff to perform both functions for a minor crop.

If general aspects of germplasm evaluation are added to this list of activities, the capabilities needed for a major crop would be 6-10

senior staff - curator, documentation specialist, pathologist(s), entomologist, geneticist/breeder(s), agronomist and a soil scientist. The number of senior staff required for a minor crop would be 3-4 persons - curator, documentation specialists, pathologist and geneticist/breeder.

A typical situation would be when the whole range of germplasm research activities is included in the programme. The number of senior staff required for such a programme could be 20-25 for a major crop and 8-10 for a minor crop. The skills required would be generally the same as stated under germplasm conservation, characterization and general evaluation. However, increased capability would be needed in pathology, entomology and perhaps physiology to ensure thorough understanding of the major diseases, pests and stresses affecting the crop. This would also facilitate an efficient search for genetic traits in the world germplasm collection.

11.6.2. Ecoregional Centre Model

TAC considers that the following thrusts and features would be common for the research programmes of ecoregional centres:

(a) understanding the strengths and weaknesses, including the major characteristics, of the natural resource endowment of the ecoregion.

(b) organization of a multidisciplinary research structure with highly skilled international scientific teams to work on major resource-related constraints of the ecoregion. Such multidisciplinary teams will present a special strength to commodity research and adaptation in a given ecoregion.

In TAC's view ecoregional centres should organize their agroecological work zone into teams that focus on research domains. Most ecoregional centres would be expected to work on three or more research domains.

Certain skills and strengths of the ecoregional centres would need to be of center-wide relevance to enhance the effectiveness of the research domain teams. Examples would include: land use specialists, biometrics/statistics, training specialist(s), library documentation, outreach, ecologically oriented entomologist(s) and pathologist(s), anthropologist(s) and agroclimatologist(s).

The team for a research domain might comprise 8-10 scientists in the following disciplines:

(i) Soil Science: Including soil physics, soil microbiology, soil fertility, and tillage.

(ii) Agroclimatology: An agroclimatologist may be necessary for most research domain teams where differences in climate between research domains are great. In other cases one agroclimatologist for the centre may be enough.

(iii) Economics/Social Science

(iv) Agronomy/Physiology/Plant nutrition

(v) Hydrology/Water management

(vi) Forester(s).

It is being assumed that an ecoregional centre that has, for example, three research domains and includes forestry in its programme will have about 60-65 senior staff. To enhance partnership from the beginning, ecoregional centres should have financial provision for visiting scientists from developing countries. Several scientists from commodity centres would be stationed at the ecoregional centres to undertake activities related to germplasm and crop improvement specific to that ecoregion and to provide linkages to the global commodity centres.

11.6.3. Conclusions

The purpose of exploring the medium-term vision and its operational and financial implications has been to understand the possible nature of the CGIAR after a period of expansion in the early nineties. As discussed above, the short-term financial needs of the existing and expanded CGIAR will require a growth in funding of the order of 10% over the next five years. Nevertheless the context of a restructured CGIAR in the year 2005 which will be about the same size of the current CGIAR should be reassuring in considering the current expansion.

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ANNEX I

LIST OF REGIONAL MEETINGS OF LEADERS OF NATIONAL RESEARCH SYSTEMS WHICH WERE CONSULTED

DATE	VENUE	MEETING
December 1989	Cairo	AARINENA
April 1990	Antananarivo	CORAF
April 1990	Montevideo	PROCISUR
April 1990	Gaborone	SACCAR
May 1990	Quito	PROCIANDINO
June 1990	San Jose	Central America
June 1990	Port of Spain	CARDI
July 1990	Kuala Lumpur	ASEAN-COFAF

ANNEX II

GUIDELINES FOR TAC PANELS APPOINTED TO ASSESS THE NON-ASSOCIATED CENTRES

Panels should base their assessments on the analytical work undertaken by the TAC and CGIAR Secretariats. In particular, they should take fully into account:

(i) the revised statement of the CGIAR mission and goals;

(ii) the TAC paper entitled "A Possible Expansion of the CGIAR: Part I Interim Report";

(iii) the revised paper entitled "Activities and Modes of Operation in the CIAR System"; and

(iv) further analyses provided by the Secretariats - as outlined in this note.

Against this general background, the Panel should proceed to make its assessments by thorough consideration of the issues outlined below:

1. What should be the future CGIAR activities if any, in the general area of .....? The Panel should base its assessment on the revised statement of CGIAR mission and goals, the needs identified in the "Part I" paper, and current perceptions of CGIAR priorities, strategies and modes of operation.

2. To what extent do existing CGIAR Centres meet the demand for research in this area? The Panel's assessment should be based on material assembled by the Secretariats (to be provided).

3. To what extent, with respect to subject-matter coverage, do the activities of the relevant non-associated centre(s) (a) fill gaps in, (b) complement, or (c) duplicate current work supported by the CGIAR, or undertaken by other institutions? The Panel should base its conclusions on the analyses provided by the Secretariats (preliminary work by the Secretariats would help).

4. What research needs in agriculture, fisheries and forestry are not currently being met either by the CGIAR Centres or by the non-associated centres and networks?

5. To what extent do the activities and modes of operation of the non-associated centre(s) conform to those considered acceptable for CGIAR Centres? Assessment of this issue should relate to the share of research in the centre's activities, the types of research undertaken, the international character of the centre's work, its activities in training and information services, and its relationships with national research systems. (Preliminary analysis to be undertaken by the Secretariats - see Tables 1-3 for outline).

6. To what extent do the non-associated centre(s) conform to the preferred institutional nature of a CGIAR Centre, with respect to:

   (a) Mandate (prepare overall analysis - see Table 4)

   (b) Governance (use information in reports of fact-finding missions)

7. From consideration of the above issues, is there a case for considering admission of the non-associated centre(s) into the CGIAR? If "yes", the panel should refer this provisional conclusion to TAC for further consideration. If "no", the Panel should consider whether some of the activities of the centre meet the criteria in 3, 5 and 6. If they do, then the following options should be considered:

   (a) Could the centre usefully be modified to make it appropriate for CGIAR support?

   (b) Should the activities be incorporated into (an) existing CGIAR Centre(s)?

   (c) Should the activities be incorporated into another non-associated centre under consideration for inclusion in the CGIAR?

   (d) Is there another option that would be more appropriate?

8. What institutional options would be appropriate for incorporating into the CGIAR system those research activities in agriculture and forestry not currently covered either by the CGIAR or non-associated centres, or by other institutions?

Before proceeding further, the Panel should address the questions in Appendix A and then refer its conclusions to TAC (see Decision Tree, Appendix B). TAC will discuss how to proceed further, especially with respect to quality criteria and resource implications (Appendix C).

Appendix A

ADDITIONAL SPECIFIC QUESTIONS FOR TAC PANELS

ON THE NON-ASSOCIATED CENTRES

1. Do you confirm or differ from TAC's previous views on the relevance of the subject matter area for CGIAR support?

2. On the basis of the documentation provided do you consider additional information to be necessary before a clear-cut decision could be made on the role of the CGIAR in the subject matter area? If so, what type of information would you need?

3. Is it your considered opinion that a further visit by a TAC Panel to the Centre(s) would be useful? If so, what would be the nature and scope of such visit?

4. What are the pros and cons of the institutional options suggested in the desk analysis? Can you think of other modes of operation? What would be your preferred options(s)?

5. What are the implications of the proposed options(s) on the future structure and organization of the CGIAR?

Annex II

TABLE 1: RESEARCH AND RELATED ACTIVITIES

	Centres					
	1	2	3	4	5	etc.
Proportion of budget allocated to: *						
Research:						
— strategic						
— applied						
— adaptive						
Development of research capacity:						
— training						
— technical assistance ++						
— financial assistance ++						
— information & communications						

(*) The total will not sum to 100%

(++) To individual national programmes and through networks

Also required: Breakdown to show proportions of budget allocated to (i) research (ii) related activities and (iii) administration, etc.

TABLE 2: RELATIONSHIPS WITH NATIONAL PROGRAMMES

A. COLLABORATION WITH INDIVIDUAL COUNTRIES (DEVELOPED OR DEVELOPING)

	Country or Project					
	1	2	3	4	5	etc.
Purpose of collaboration						
— Strategic research						
— Applied research						
— Adaptive research						
— Extension						
— Institution-building						
Types of relationship:						
— Collaborative						
— Contracting						
— Enabling						
Role(s) of centre in the collaboration:						
— Leader/controller						
— Customer						
— Partner/collaborator (no funding from Centre)						
— Donor						
— Channel for funding						

The above analysis should be accompanied by a list of projects and their objectives.

TABLE 2: RELATIONSHIPS WITH NATIONAL PROGRAMMES

B. PARTICIPATION IN NETWORKS

	Networks					
	1	2	3	4	5	etc.

Main purpose of network:

- — Strategic research
- — Applied research
- — Adaptive research
- — Extension
- — Institution-building

Type of network:

- — Collaborative
- — Research contracting
- — Research enabling

Role(s) of Centre in the network:

- — Administrator/controller
- — Scientific coordinator
- — Partner/collaborator (no funding from Centre)
- — Scientific consultant/ provider of germplasm
- — Channel for funding

The above analysis should be accompanied by a list giving the title of the network, its objectives and the participating countries.

TABLE 3: TRAINING AND INFORMATION SERVICES

Analysis of training in terms of:

- production
- research
- on-farm research
- advanced degree
- post-doctoral
- sabbatical

Analysis of information services in terms of:

- production/extension
- research
- education

TABLE 4: NATURE OF MANDATE

	Centres					
	1	2	3	4	5	etc.
Mandate defined mainly in terms of:						
Discipline(s)						
Resource management						
Commodity (ies)						
Geographical region						
Agro-ecological zone						
Institution-building						

Appendix B

Decision Tree for Next Steps in Assessing Non-Associated Centres

Provisional case established for inclusion of the centre on grounds of subject-matter, modes of operation, mandate and governance

Yes — No

Some activities qualify

Proceed to quality criteria after discussion by TAC (Appendix C) — Yes — No

Consider options

Modify centre to conform to CGIAR pattern		Incorporate into existing CGIAR Centre(s)		Incorporate into another NAC or NACs	
Yes	No	Yes	No	Yes	No

Proceed to quality criteria after discussion by TAC (Appendix C)

Appendix C

QUALITY CRITERIA

Qualifications and international standing of professional staff

Quality and output of work

Potential for impact (needs thought especially in relation to poverty alleviation and income generation)

Effectiveness of management

Cost-effectiveness of centre or activity

ANNEX III

TAC PANELS FOR THE NON-ASSOCIATED CENTRES

1. Banana and Plantain Research

(a) TAC Members	Field of Specialization/Experience
A. Muhammed - Chairman	Biochemistry and Microbiology
E. Paterniani	Plant Breeding and Genetics
G. Scarascia-Mugnozza	Plant Breeding and Genetics
(b) Consultants	
R. Fullerton (New Zealand)	Plant Pathology (work on Black Sigatoka Disease), New Zealand Dept. of Scientific & Industrial Research
N. Simmonds (UK)	Genetics and Plant Breeding. Consultant. Former Director, Scottish Plant Breeding Inst.
R.H. Stover (USA)	Consultant. Plant Pathologist. Former Banana Breeder with United Fruit Co.
(c) Resource Person	
J. Monyo (TAC Secretariat)	Plant Breeding and Genetics

2. Research on Livestock Diseases in sub-Saharan Africa

(a) TAC Member	
C. Chantalakhana - Chairman	Animal Science
(b) Consultants	
W.R. Pritchard (USA)	Professor of Veterinary Medicine, University of California, Davis
J.F. Tilak Viegas (Portugal)	Population & Quantitative Genetics/ Veterinary Medicine. Associate Prof., Epidemiology & Economics, Veterinary Faculty, Technical University of Lisbon, Portugal
(c) Resource Persons	
C. Hoste (FAO, Banjul)	Animal Genetics
J. Monyo (TAC Secretariat)	Plant Breeding and Genetics

3. Crop Protection Research

(a) TAC Members	Field of Specialization/Experience
M.H. Arnold - Chairman	Plant Breeding and Genetics
E. Paterniani	Plant Breeding and Genetics
(b) Consultants	
L. Brader (FAO, Rome)	Entomology. Director, Plant Production and Protection Division
D. MacKenzie (USA)	Plant Pathology. Director, National Biological Impact Assessment Programme, Cooperative State Research Service, U.S. Department of Agriculture
G.H.L. Rothschild (Australia)	Entomology. Director, Australian Centre for International Agricultural Research (ACIAR)
(c) Resource Persons	
A. Kassam (TAC Secretariat)	Agronomy
H. Palmier (CGIAR Secretariat)	Law and Economics
D. Plucknett (CGIAR Secretariat)	Soil Science

4. Natural Resources Conservation Management Research

(a) TAC Members	
M.H. Arnold - Chairman	Plant Breeding and Genetics
G. Budowsky	Forestry/Agroforestry
K. Chowdhry	Management Specialist
R. Dudal	Soil Science
(b) Consultants	
J.R. Anderson (Australia)	Economics. World Bank, Washington, D.C., USA
J. Brewbaker (USA)	Tree Breeding & Genetics/Nitrogen Fixing Tree Association, Hawaii, USA
J. Burley (UK)	Forest Genetics, Tree Improvement and Wood Quality. Director, Institute of Forestry, University of Oxford
E.T. York (USA)	Agronomy. Chancellor Emeritus, University of Florida, International Programmes. Former TAC Member
(c) Resource Persons	
M. Collinson (CGIAR Secretariat)	Economics
E. Craswell (TAC Secretariat)	Soil Science

5. Fisheries

(a) TAC Members	Field of Specialization/Experience
J.G. Ryan - Chairman	Economics
K.I. Hayashi	Plant Breeding and Genetics

(b) Consultants

J. Beardmore (UK)	Professor of Genetics & Head, School of Biological Sciences, University College of Swansea, Wales, U.K.
H.F. Henderson (FAO)	Director, Fisheries Resources and Environment Division, Rome
V.R.P. Sinha (India)	Fisheries/Freshwater Aquaculture. Director, Freshwater Aquaculture Research and Training Centre, Bhubaneswar, Orissa, India
J.P. Troadec (World Bank)	Consultant. Team Leader, Study of International Fisheries Research

(c) Resource Persons

G. Gryseels (TAC Secretariat)	Economics
A. Kassam (TAC Secretariat)	Agronomy
D. Plucknett (CGIAR Secretariat)	Soil Science

6. Forestry

(a) TAC Members

H.M. Gregersen - Chairman	Forest Resource Economics
K. Chowdhry	Management Specialist
M. Matsui	Silviculture
I. Nahal	Forest Ecology
S.M. Nor	Forest Resources Management

(b) Consultants

P. Kio (Nigeria)	Director, National Forestry Research Institute, Nigeria
J.P. Lanly (FAO)	Director, Forest Resources Division, FAO, Rome
P. Oram (UK)	Economics. Senior Research Fellow Emeritus, IFPRI
J. Turnbull (Australia)	Tree Breeding and Genetics. Forestry Programme Coordinator, ACIAR

(c) Resource Persons

E. Craswell (TAC Secretariat)	Soil Science
O. Khan (CGIAR Secretariat)	Consultant, Economics
J. Spears (CGIAR/TAC Secretariats)	Forestry

7. Vegetables

(a) TAC Members	Field of Specialization/Experience
E. Muchnik de R. - Chairperson	Economics
D.H. Calloway	Human Nutrition
C. Chantalakhana	Animal Science
G. Scarascia-Mugnozza	Plant Breeding and Genetics

(b) Consultants

E.T. York (USA)	Agronomy. Chancellor Emeritus, University of Florida, International Programmes. Former TAC Member
G.J.H. Grubben (Netherlands)	Plant Breeding and Genetics. Project Leader, Research on Lowland Vegetables, Lembang Horticultural Research Institute, Indonesia
H.C. Wien (USA)	Horticulture/Agronomy. Associate Professor, Department of Vegetable Crops, Cornell University, Ithaca

(c) Resource Persons

L. Field (CGIAR Secretariat)	Management
G. Gryseels (TAC Secretariat)	Economics
O. Kahn (CGIAR Secretariat)	Consultant, Economics
C. McClung (Winrock Int.)	Soil Science. Regional Representative, Asia

8. NARS/IARCs Interface

(a) TAC Members

M.H. Arnold - Chairman	Plant Breeding and Genetics
A. Muhammed	Biochemistry and Microbiology

(b) Consultants

E. Moscardi (Argentina)	Economics. Director General, National Institute of Agricultural Technology (INTA), Argentina
M. Touré (World Bank)	Soil Science. Executive Secretary, Special Programme for African Agricultural Research (SPAAR)

(c) Resource Persons

A.F. McCalla (TAC Chairman)	Economics
A. von der Osten (Executive Secretary, CGIAR Secretariat)	Economics
O. Khan (CGIAR Secretariat)	Consultant, Economics
J. Monyo (Exec. Sec., TAC)	Genetics and Plant Breeding
H. Palmier (CGIAR Secretariat)	Law and Economics
J. Spears (CGIAR Secretariat)	Forestry

ANNEX IV

POSSIBLE REGIONAL RESEARCH THRUSTS IN THE AREAS OF AGROFORESTRY, WOODY GERMPLASM COLLECTION, AND EVALUATION, MPT SPECIES SELECTION/IMPROVEMENT, NATURAL FOREST MANAGEMENT/SILVICULTURE, FORESTRY/AGROFORESTRY POLICY APPROPRIATE FOR SUPPORT BY THE CGIAR SYSTEM [1][2]

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[1] We emphasize that this is an illustrative exercise and not a comprehensive research agenda. Illustrations for the IARC's have not been approved by them.

[2] Even though the various topics discussed are treated separately in this Annex, it is recognized in practice that many of them would need to be integrated closely at the research center level.

Agroforestry: Illustrative listing of possible global strategic research thrusts of common interest to the regions[1]

1. **Agroforestry/forestry agroecological zoning, land use capability surveys**

   - GIS/Land use capability survey, with special reference to encroached forest lands
   - Characterization of environments where agroforestry systems may be used
   - Development of process models which simulate the response of systems to varying environments
   - Measurement of long term sustainability of land use systems
   - Potential for adoption of agroforestry systems under situations of increasing population density and shorter fallow periods.

2. **Component interactions in agroforestry cropping systems:**

   - Nutrient and biomass cycling and crop/tree interactions
   - Impact of trees on crop moisture availability
   - Rhizosphere research (mycorrhizae, N-fixing symbionts)
   - Allelopathy
   - Role of trees as biological control agents of pests and diseases
   - Management of pests and diseases in agroforestry systems

3. **Role of trees in land management (pastures, degraded lands)**

   - Shade effects on crop and animal productivity
   - Amelioration of soils-nutrition, stabilization of forest fallows
   - Nutritional and toxicological aspects of tree browse
   - Hydrological research (e.g.-, role of trees in regulating runoff)
   - Role of trees in erosion control

[1] Notethat agroforestry policy and socioeconomic research is covered in Annex IV, Table 8, even though in practice much of such research would be closely integrated with the physical/biological research.

Woody Germplasm: Collection, exploration, characterization, and conservation.

Illustrative listing of possible global thrusts of common interest to the regions[1][2]

1. Germplasm collection and exploration

1-1. Possible strategic research topics
- Grower/user assisted prioritization of species
- Systematic biology, including clarification of taxonomic synonyms
- Biogeographic mapping and descriptions of species distributions
- Assessment of genetic diversity and degree of endangerment
- Conservation strategies for maintenance of the gene pool
- Germplasm of root symbionts, collection, isolation, assessment

1-2. Possible applied research topics
- Define regions of optimal genetic diversity of major MPT legumes
- Germplasm acquisition, including field collections of seeds

2. Germplasm characterization

2-1. Possible strategic research topics
- Botanical characterization and physical description of species and provenances, including morphology and cytology
- Breeding systems, including phenology and pollination biology
- Biochemical properties
- Rhizosphere research (mycorrhizae and N-fixing symbionts)
- Entomology and pathology to identify pests and diseases of probable concern of distributed widely

2-2. Possible applied research topics
- Development of herbaria and arboreta in appropriate ecosystems

3. Seed production and germplasm conservation

3-1. Possible strategic research topics
- Seed biology and maintenance of genetic and physiological integrity
- Identification and management of recalcitrant seeds and embryos
- Seed-borne pathogens
- Insect pests of seed development or storage
- Quarantine procedures and requirements
- Clonal germplasm development, including tissue culture

3-2. Possible applied research topics
- Seed viability loss in storage
- Seed orchard management, including spacing, pollarding and conditions for optimal seed harvest
- Field control of seed pathogens and insects
- Methods of pollination for pure-seed or hybrid seed production

---

[1] Research thrusts in this area would not differ significantly from one region to another.

[2] IBPGR would play a key role in this area.

MPTS selection and improvement:

Illustrative examples of possible global thrusts of common interest to the regions[1][2]

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1. MPT species and provenance selection, evaluation and description

1-1. Possible strategic research topics
- Development of audiotapes related to grower/user priorities
- Database development and convergence (germplasm accessions, herbarium collections,tree performance)
- Methodologies of site-species matching (including climatic matching)
- Assessment of genetic variation (isozymes, RFLPs) in natural and derived populations
- Experimental designs to optimize efficiency of inputs
- Identification of minimum set of experimental sites (e.g. through cluster analysis)
- Biochemical, pharmaceutical, fodder and food properties of desired products
- Physical properties (e.g. density, fiber quality, moisture content, charcoal acceptability) of wood and wood products
- Environmental tolerances (e.g. temperature, moisture, acidity, wind, salinity, weed competition)

1-2. Possible applied research topics
- Test effectiveness of selection criteria and methodology
- Selection of lines suitable for domestic use (with or without thorns, caustic sap, smokiness, etc.)
- Selection for disease and insect tolerance in MPTs
- Adaptability to management, e.g. coppicing, intercropping, browsing
- Root and stem form responses to environment
- Growth, yield (volume, weight) and harvest index
- Methodology of estimating yields

2. MPTs genetic improvement

2-1. Possible strategic research topics
- Heritability and quantitative genetics of key traits
- Genotype x environment interactions of key traits
- Breeding strategies that optimize rates of genetic gain
- Cloning and grafting technology

2-2. Possible applied research topics
- Breeding lines to maximize yields under specific management systems
- Breeding to resolve problems of disease, pest, stress
- Use of clones to optimize production systems

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(1) Basic research thrusts in this area would not differ significantly from one region to another.

(2) Research in this area would be closely linked with socioeconomic research to determine farmer's perceptions of the usefulness of trees, choice of species and organizational systems (see Table 8).

Natural Forest Management/Plantation Forestry:

Illustrative listing of research topics of common interest to the regions

1. Agroecological zoning/land use capability research in encroached forest lands (with special reference to addressing the shifting cultivation problem in most tropical and upland forest sites and setting aside unique ecosystems for preservation of biodiversity.[1]

2. Management and regeneration of natural forests (with special reference to the forests of the humid zone and increasing the productivity of secondary (logged over) forest land.

3. Reclamation of degraded forest lands (with special emphasis on saline and acid soils, restoration of fertility in forest fallows, and introduction of fast growing compensatory plantation species for fuelwood, industrial and other uses.)[1]

[1] Under the institutional options examined in Annex VI, much of the research in these two areas would fit more into an agroforestry rather than a forestry reserach institutional agenda (See Annex VI, page ....)

[1] Under the institutional options examined in Annex VI, much of the reserach in these two areas would fit more into an agroforestry rather than a forestry research institution agenda (See Annex VI).

Asia Region:

Illustrative examples of possible CGIAR-supported natural forest management/plantation forestry research activities.

POSSIBLE RESEARCH THRUSTS	POSSIBLE STRATEGIC RESEARCH TOPICS	POSSIBLE APPLIED RESEARCH TOPICS
1. Agroecological zoning/land use capability research in encroached forest lands (with special reference to addressing the shifting cultivation problem in tropical and upland forest sites) and setting aside of unique ecosystems for conservation of biodiversity.	• Methods of GIS land use capability survey. • Characterization of forest land environments where either agriculture/agroforestry or forestry land use systems may be most appropriate. • Development of process models which simulate likely forest land use change under different population pressure and land use change scenarios (to be closely linked with policy research - see Table 8)	• Application of GIS land use capability research at the national level.
2. Management and regeneration of natural forests (with special reference to the forests of the humid tropic zone.)	• Standardized methods for biological research (gap studies) that could lead to less damaging harvesting systems for the tropical rainforest. • Data handling methods for uneven aged poly-specific forests, growth and yield modelling. • Autecological studies of the behavior of component species.	• Application of improved gap study research at the national level and incorporation results into forest management and timber concession license agreements.
3. Reclamation of degraded forest lands (with special emphasis on saline and acid soils, restoration of fertility in forest fallows, and introduction of *fast growing* compensatory plantation species for fuelwood, industrial and other uses).	• Soil microbiology (N-fixation), soil nutrient mycorrhizal research related to fast-growing species. Research to extend the tolerance of Rhizobia and Frankia to soil, chemical and nutrient stress, and to produce more robust inoculum for marginal sites. • Biomass and nutrient cycling. • Growth and yield modeling studies. • Nutritional requirements of different species under nonsaline, saline and saline-sodic conditions. • Hydrological research (water use characteristics of different species, with special reference to marginal sites).	• As an extension of MPT selection and improvement research and of the strategic research (opposite), species networks to test improved establishment/silvicultural/tree management technologies for fast-growing species at the national level.

Africa Region:

Illustrative examples of possible CGIAR-supported natural forest management/plantation forestry research activities.

POSSIBLE RESEARCH THRUSTS	POSSIBLE STRATEGIC RESEARCH TOPICS	POSSIBLE APPLIED RESEARCH TOPICS
1. Agroecological zoning/land use capability research in encroached forest lands (with special reference to addressing shifting cultivation problems as they affect the moist, tropical rainforest in the west and central African region).	• Methods of GIS land use capability survey. • Characterization of forest land environments where either agriculture/agroforestry or forestry land use systems may be most appropriate. • Development of process models which simulate likely forest land use change under different population pressures and land use change scenarios (to be closely linked with policy research - see Table 8)	• Application of GIS land use capability research at the national level.
2. Management and regeneration of natural forests: (a) humid, wed tropics, (b) arid and semi-arid zone, dry forest	• In the wet zone, standardized methods for biological research (gap studies) that could lead to less damaging harvesting systems for the tropical rainforest. • Data handling methods for uneven aged poly-specific forest. • Growth, yield and modeling studies under alternative management regimes. Further testing of silvicultural techniques being applied by CTFT in the Yapo Forest. • Autecological studies of the behavior of component species. • Redevelopment of indigenous systems for savanna management. • In the dry zone, consolidation of the already available data on appropriate silvicultural management and early burning technologies for increasing the productivity of savanna woodlands for multiple purpose end use (fodder, fuelwood, honey, medicinal products, timber, charcoal, etc.)	• Application of improved gap study research at the national level and incorporation results into forest management and timber concession license agreements.
3. Reclamation of degraded forest lands (with special reference to restoration of fertility in forest fallows, establishment of fast-growing compensatory MPTS species for fuelwood fodder and industrial uses.	• Soil microbiology (N-fixation), soil nutrient mycorrhizal research related to fast-growing species (e.g., research to extend the tolerance of Rhizobia and Frankia to soil, chemical and nutrient stress, and to produce more robust inoculums for marginal sites. • Biomass and nutrient cycling • Growth and yield modeling studies, e.g., south and east African CCT plots. • Hydrological research (water use characteristics of different species, with special reference to marginal sites).	• As an extension of MPT selection and improvement research and of the strategic research (opposite), species networks to test improved establishment/silvicultural/tree management technologies for fast-growing species at the national level.

LAC Region: Illustrative examples of possible CGIAR-supported natural forest management/plantation forestry research activities.

POSSIBLE RESEARCH THRUSTS	POSSIBLE STRATEGIC RESEARCH TOPICS	POSSIBLE APPLIED RESEARCH TOPICS
1. Agroecological zoning/land use capability research in encroached forest lands (with special reference to addressing the shifting cultivation problem in moist tropical and upland forest sites).	• Methods of GIS land use capability survey. • Characterization of forest land environments where either agriculture/agroforestry or forestry land use systems may be most appropriate. • Development of process models which simulate likely forest land use change under different population pressure and land use change scenarios (to be closely linked with policy research - see Table 8)	• Application of GIS land use capability research at the national level.
2. Natural forest management with special reference to increasing productivity of secondary (i.e., logged over or degraded) forest land. (Building on the work of CATIE, ITF, OTS and STRI.)	• Standardized methods for biological research (gap studies) that could lead to canopy manipulation and regeneration options in secondary forests. • Data handling methods for uneven aged poly-specific forests. • Autecological studies of the behavior of component species.	• Application of improved gap study research at the national level and incorporation results into forest management and timber concession license agreements.
3. Improving the productivity of fast growing species for planting in upland sites (e.g., the Andean region of Ecuador, Peru, Colombia). Special reference to problems of compacted soils. Use of tree species for improving soil fertility in forest fallows, planting of multipurpose and industrial species for commercial scale reforestation programs in situations where the main beneficiaries will be either (a) small-holder, cash crop tree farmers (e.g., cash-crop tree farming in Melia azederach for pulpwood production in Paraguay, and possible involvement of small-holders in cash crop P. radiata and Eucalyptus pulpwood production in Brazil and Chile) or (b) larger scale industrial plantations..	• Soil microbiology (N-fixation), soil nutrient mycorrhizal research related to fast-growing species (e.g., research to extend the tolerance of Rhizobia and Frankia to soil, chemical and nutrient stress, and to produce more robust inoculum for marginal sites. • Biomass and nutrient cycling. • Growth and yield modeling studies relevant to increasing biomass output under intensive management systems. • Hydrological research (water use characteristics of different species, with special reference to marginal sites).	• As an extension of MPT selection and improvement research and of the strategic research (opposite), species networks to test improved establishment/silvicultural/tree management technologies for fast-growing species at the national level.

Forestry and Agroforestry Policy and Socioeconomics: *Illustrative examples of possible global CGIAR-supported research* activities of common interest to the regions[1]

POSSIBLE RESEARCH THRUSTS RELATED TO:	ILLUSTRATIVE STRATEGIC AND APPLIED RESEARCH
1. Trees and security of household welfare with a focus on agroforestry systems and community forestry;	• understanding the institutional environment that affects tree growing behavior, including market availability; government price and incentive policies; infrastructure policies and access; population policies; intersectoral policy issues; • costs and benefits associated with agroforestry; including micro and macro policies and economic issues; distributional issues; • household and village decision making structures and their relationship to adoption of agroforestry practices; • economics and policy issues related to small-scale rural enterprises based on outputs from forests and agroforestry systems; intersectoral policy issues; • evaluation of donor policies and programs;
2. Deforestation and inappropriate land use in the wet tropics (with special reference to control of inappropriate natural forest logging and conversion to nonsustainable agriculture);	• land use zoning and planning procedures and policies; • economics of more sustainable land use systems using agroforestry technologies; • valuing the multiple goods and services from the natural forest; • economics of sustained yield management for timber and other products; • policies regarding forest utilization and government forest revenue and management systems; • policies regarding plantation development in relation to natural forest protection;
3. Deterioration of dryland forests and wastelands; causes of deterioration and rehabilitation opportunities using trees;	• social and economic causes of land deterioration; • land tenure issues in drylands; policies and practices for common property and open access lands; • food and fodder security issues; • policies related to agricultural mechanization, irrigation, energy, livestock and settlement affecting management and use of dryland forests;
4. Upland watershed deterioration in relation to well-being of upland users as well as downstream populations;	• land use planning and zoning; • land use carrying capacities in relation to alternative management strategies; • economic and social significance of upstream-downstream linkages in land use; • role of infrastructure policies on land use and land deterioration; • tenure issues in relation to land deterioration; • economic role of upland forests in the lives of local people.

[1] Some of the policy research, particularly at the farm level, forms part of ICRAF's ongoing research agenda. IFPRI has a comparative advantage in some areas. Other topics would be carried out under contractual research agreements between a centralized CGIAR Forestry/Agroforestry Research Center and specialized policy research agencies.

ANNEX V

SOME OF THE LIKELY MAIN REGIONAL/NATIONAL AGRICULTURE/FORESTRY AND SPECIALIZED RESEARCH CENTERS WITH WHICH A CENTRALIZED CGIAR FORESTRY/AGROFORESTRY CENTER(S) WOULD HAVE TO COLLABORATE[1]

[1] A preliminary illustrative and not comprehensive listing.

ASIA REGION: Illustrative listing of some of the main agroforestry/forestry research institutions/research networks with which a CGIAR-supported global research institute would want to collaborate/cooperate

Annex V - Table 1

AGROFORESTRY	WOODY GERMPLASM CONSERVATION/EVALUATION[a]	MPTS SELECTION AND IMPROVEMENT	NATURAL FOREST MANAGEMENT AND SILVICULTURAL RESEARCH	POLICY/SOCIOECONOMIC RESEARCH[b,c]
ICRISAT (India) • Agroecological zoning/land use capability research in semi-arid zone. • Expansion of ongoing, collaborative agroforestry research work with CRIDA in India expanded to a collaborative network with leading NARS. IRRI (Philippines) • Agroecological zoning/land use capability research in the humid tropics. • Expansion of ongoing, on-farm tree/rice interaction research in collaboration with leading NARS	ICRISAT (global collection of Cjanus/spp.) NFRs National Tree Seed Center in, e.g. Indonesia, Thailand, Vietnam, Philippines BAIF (India) Working on local collection of Albizia, Dalbergia, Leucaena ASEAN/IDRC financed Canada Tree Seed Centre (Thailand) DANIDA (pines and teak: Thailand/Burma) NFTA (Hawaii) N-fixing MPTS CSIRO plus ACIAR (Australia) Ongoing collection, evaluation and conservation of germplasm of key MPT species, e.g., Acacia Casuarina, Eucalyptus and Grevillae, for multipurpose end uses FAO Regional germplasm evaluation network	RFD and Faculty of Forestry, Kasetsart University (Thailand), selection and improvement of MPTS for a range of end uses (e.g., fodder, fuelwood, timber) NFRs in 12 different countries supported by Winrock's F/FRED MPTS Program, which covers some 12 MPT species and in two main agroecological zones, i.e., • humid and semi-humid • arid and semi-arid FRIM (Malaysia) Humid tropical zone IDRC Bamboo/Rattan Network (Singapore) for multiple end use NFTA (Hawaii) - N-fixation, breeding and network evaluation of N-fixing MPTS CSIRO (Australia) and QFS • scientific support to above research networking activities, testing, evaluation of MPTS in various agroforestry tree/crop/ livestock combinations and industrial planting situations IITO: Policy aspects of sustained yield management of industrial forests. FAO: Regional FORSPA network and various bilateral and multilateral aid programs for strengthening capability of national research institutions.	ASEAN Institute of Forest Management (UPLB, Philippines) Agroecological mapping/biomass inventory/land use capability research. AIFM Gap studies in natural forests, rainforests; growth/yield modeling. FRIM (Malaysia) Networking with e.g., BIOTROP (Indonesia) and UNITECH (PNG) FF Kasetsart and RFD (Thailand) NFRS e.g., AFRD (Indonesia) and UPLB (Philippines) Compensatory fast-growing species network for reclamation of imperata grassland for multipurpose end uses in conjunction with FRI's in Philippines, Indonesia PNG. CAZRI (India) Saline soil reclamation networks (in association with NRFs/NARS in Pakistan, India, Thailand). ACIAR and QFS (Australia) Saline Soil and Acid Soil Research Programmes and national forest management (all of the above)	• University of Los Banos (Philippines) Shifting cultivation pressure in encroached forest lands, policy options for minimizing ecological damage. Indian Institute of Management (India) Socioeconomic policy research into the impact of social forestry programs on availability of fuelwood and fodder for rural poor. Options for reclamation of degraded forest land. • Perumperhutani (Indonesia) Policy studies on timber extraction and concession policies. Options for increasing economic rent capture and implications for sustainable forest management. East-West Center Policy support to above. Planning Division Ford Foundation (India) Studies of smallholder farming policy issues in forests. F/FRED Studies of villages motivation for tree planting. IITO Policy aspects of sustained yield management of natural FAO Institutional policy

[a] It is assumed that IBPGR would play a lead role in scientific research needs in this area.
[b] It is assumed that IFPRI would play a lead role in this area in direct collaboration with national institutions.
[c] In addition to the above, which deals with major research thrusts, it is assumed that ISNAR would play a role in strengthening research organization and management for many of the above institutions.

AFRICA REGION: Illustrative listing of some of the main agroforestry/forestry research institutions/research networks with which a CGIAR-supported global research institute would probably want to collaborate/cooperate

AGROFORESTRY	WOODY GERMPLASM CONSERVATION/EVALUATION[a]	MPTS SELECTION AND IMPROVEMENT	NATURAL FOREST MANAGEMENT AND SILVICULTURAL RESEARCH	POLICY/SOCIOECONOMIC RESEARCH[b,c]
ICRAF (Kenya) • Agroecological zoning • Agroforestry component interaction research in association with NARS/NFRS IITA (Nigeria) • Agroecological zoning • Agroforestry component interaction research • Role of trees and woody plants in fallow management of degraded forest lands in association with NARS/NFRS. ILCA (Ethiopia) • Role of trees/woody shrubs as a source of animal feed and erosion control in association with NARS/NFRS. ICRISAT (Niger) • Sahelian trees in local cropping systems NARS (e.g., Burkina Faso, Nigeria, Ghana, Kenya and many other countries working on AF systems) (see ICRAF AFRENA network) ORSTROM (Cote d'Ivoire) • soil surveys and land use capabilities CTFT (France) • Sahelian fodder tree systems NFTA Various multilateral/bilateral and programming priority support to strengthening of research capability of NARS	ICRAF (Kenya) Acquisition of MPTS, characterization, regional evaluation. IITA (Nigeria) Acquisition of MPTS, characterization, regional evaluation ILCA (Ethiopia) Collection of fodder, trees and shrubs, characterization, regional evaluation ICRISAT Acquisition and characterization of Sahel AF system trees FRIN (Nigeria) Acquisition, characterization and evaluation of germplasm for key MPT species for the humid and arid zones KEFRI (Kenya) • Indigenous MPTS suitable for the east and central African highlands FRC (Zimbabwe) Indigenous MPTS suitable for countries of the SADCC region Burkina Faso (CILLS) Indigenous MPTS for the Sahel and Sudanian zone. CTFT (France) Collection, characterization of key MPTS species for the west Africa region humid and semi-arid zones (particularly *Acacia* and *Parkia* spp.) OFI (UK) Collection, characterization of MPT species (African Acacias)	ICRAF (Kenya) Regional evaluation of MPTS for agroforestry systems IITA (Nigeria) Regional evaluation of MPTS for (to date) mainly alley cropping ILCA (Ethiopia) Regional evaluation of fodder legumes FRIN (Nigeria) Selection of MPTS for the humid and semi-arid zones for a range of end uses (fuelwood, fodder) degraded land reclamation, forest fallows, industrial raw materials. KEFRI (Kenya) Indigenous species for the east and central African zone FRC (Zimbabwe) In collaboration with FRIM Malawi and other NFRs involved in an emerging MPTS network for the SADCC region Burkina Faso (CILLS) Dry zone species (Sahel Sudanian region) CTFT (France) Support to MPTS networks in the west and central Africa region NFTA Various multilateral/bilateral and programming priority support to strengthening of research capability of NFRS/NARS OFI (UK) Support to MPTS networks	FRI (Cote d'Ivoire) Humid zone natural forest silviculture network in proposed future collaboration with NFRs in e.g., Cameroon, Gabon, Congo PR CAR. IRA Silviculture of logged over forest Ghana (FDRD) Silvicultural regional research in humid rainforest of wider relevance to other countries in the same region. FRIN (Nigeria) • Applied research on plantation forestry with special reference to fast-growing, compensatory plantations for multipurpose uses. • Growth and yield modeling in plantations in association with e.g., FPR (Ghana) and FDR Division Sierra Leone) KEFRI (Kenya) Growth yield modeling and applied silvicultural research relating to woodlots and industrial plantation management in east and central Africa. FRC (Zimbabwe) As for KEFRI above, on species and silvicultural systems appropriate to the SADCC region. CTFT (France) Support to the above (mainly in west Africa) NRI and ITE (UK) Support to west African research in Cameroon	Universities of Cote d'Ivoire and Ibadan (Nigeria) • Shifting cultivation pressure in encroached natural forests of the west African region • Policy options for encouraging intensified/sustainable land use via agroforestry and other land use systems. University of Harare (Zimbabwe) • Incentives for encouragement of villagers' involvement in indigenous woodland conservation and management. University of Ibadan (Nigeria) • Timber extraction policies aimed at increased economic rent capture and improved understanding of concession license with special reference to the impact on sustainable forest management. Beijer Institute (Sweden) Policy research on smallholder incentives and fuelwood strategy WRI IIED IUCN WWF ITTO

AFRICA REGION: Illustrative listing of some of the main agroforestry/forestry research institutions/research networks with which a CGIAR-supported global research institute would probably want to collaborate/cooperate

AGROFORESTRY	WOODY GERMPLASM CONSERVATION/EVALUATION[a]	MPTS SELECTION AND IMPROVEMENT	NATURAL FOREST MANAGEMENT AND SILVICULTURAL RESEARCH	POLICY/SOCIOECONOMIC RESEARCH[b,c]
	CILSS Sahelian Tata Collection characterization SADCC Collection characterization FAO/IBPGR Acacia Program Support to regional NFRs, strengthen research capability to coordination of germplasm work via FAO Forest Genetic Resources Committee	ACIAR (Australia) Selection and improvement of MPTS of relevance to the Africa region IDRC (Canada) Support to the SADCC regions countries Tree Seed Centre located in FRC Zimbabwe ITE (Scotland) Selection and improvement of higher value west African hardwoods (e.g. Terminalia, Triplichiton spp.) FAO Sahel/Sudanian network Support to all the above.	NFTA Various multilateral/bilateral and programming priority support to strengthening of research capability of NFRS/NARS OFI (UK) Support to all of the above (mainly in west and south Africa) IUCN Support to west Africa region Natural forest management research ACIAR/QFS (Australia) Support to all of the above FAO Technical assistance to strengthen research capacity of national institutions.	

[a] IBPGR would play a lead role in scientific research needs in this area in collaboration with FAO.
[b] IFPRI would play a lead role in this area in direct collaboration with national institutions.
[c] ISNAR would play a role in strengthening of research organization and management in many of the above institutions.

LAC REGION: Illustrative listing of some of the main agroforestry/forestry research institutions/research networks with which a CGIAR-supported global research institute would probably want to collaborate/cooperate

Annex V - Table 3

AGROFORESTRY	WOODY GERMPLASM CONSERVATION/EVALUATION[a]	MPTS SELECTION AND IMPROVEMENT	NATURAL FOREST MANAGEMENT AND SILVICULTURAL RESEARCH	POLICY/SOCIOECONOMIC RESEARCH[b,c]
Agroforestry/forestry agroecological zoning land capability research Identification of key agroforestry zones. Land use capability research with special reference to encroached forest land. CIAT: Agroforestry zones CATIE: ROCAP GIS NARS: (CUMAT ONERN INPE) Role of trees in pasture management CIAT's ongoing Tropical Pastures Program would be the main vehicle for research thrust. Involvement in the more humid tropics (e.g. Amazon) would be limited to exploratory component interaction research (e.g., the role of pastures and leguminous trees/browsing species in recovering degraded pastures). Component interactions in agroforestry intercropping systems with special reference to competition for soil nutrient moisture and light, efficiency and management of root symbiosis, pests and diseases, fertilizer, green manure interactions. • CATIE - multistory systems, shade trees in AF systems. • INPA (Brazil) - palm-based systems • EMBRAPA - Rhizosphere research, plantation shade systems • NARS (Colombia, Peru)	• CIAT global collection leguminous shrubs for potential as acid-tolerant fodders; field explorations, characterization, seed research. • NARS (CONAF, CONAFOR, etc.)--collections of Prosopis, others • CATIE - collections of Gliricidia, Erythrina; characterization, seed research, national evaluations • NFTA - collection of genus systematic biology, characterization, evaluation global evaluations, seed research • USAD, ITF, MBG, NYBF - collections of Swietenia, Erythrina, Inga; systematic biology, characterization • CAMCORE - collections of conifers, Cordia, Swietenia • OFI - provenance collections leguminous trees, pines, cedrela, cordia in C. America; systematic biology, global evaluations • CSIRO - collections of fodder legumes in Mexico and Brazil; characterization, seed research global evaluations.	• CIAT - species selection and evaluation of trees for fodder, recovery of degraded lands, windbreak • EMBRAPA/CENARGEN - evaluation and breeding diverse woody plants • INPA - special selection evaluation, breeding of palms • NARS - species selection, evaluation • CATIE - collections of Gliricidia, Erythrina; characterization, seed research, regional evaluations • OFI - evaluations of provenance collections • CAMCORE - collections of conifers, Cordia, Swietenia . Private corporations - breeding eucalypts, diverse MPTS	Agroecological zoning, land use capability surveys CATIE (Costa Rica) COMAT (Bolivia) IBAMA (Brazil) Island Resource Foundation Gap Studies STRI (Panama) EMBRAPA (Brazil) Growth Yield/Modeling EMBRAPA (Brazil) Soil microbiology, biomass nutrients cycling, physiology, biochemistry, sustainability of intensive biomass silvicultural regimes IVIC (Venezuela) INPA (Brazil) CONAR (Chile) USP (Brazil) VICOM (Brazil) ITF (Puerto Rico)	CATIE (Costa Rica) Socioeconomic use studies of initiatives for people's involvement in watershed protection. University of Sao Paolo (Brazil) Fiscal subsidy and agricultural taxation policies which encourages deforestation.

LAC REGION: Illustrative listing of some of the main agroforestry/forestry research institutions/research networks with which a CGIAR-supported global research institute would probably want to collaborate/cooperate

AGROFORESTRY	WOODY GERMPLASM CONSERVATION/EVALUATION[a]	MPTS SELECTION AND IMPROVEMENT	NATURAL FOREST MANAGEMENT AND SILVICULTURAL RESEARCH	POLICY/SOCIOECONOMIC RESEARCH[b,c]
• CIAT - regional research on acid-tolerant fodder trees • CATIE - fodder tree, shade tree, living fences • CARDI-Caribbean fodder tree use in pasture, erosion control • NARS (Mexico, Cuba, Brazil, Honduras, etc.) - Fodder Trees FAO would play a role in all of the above.				

[a] It is assumed that IBPGR would play a lead role in scientific research needs in this area in collaboration with FAO.
[b] It is assumed that IFPRI would play a lead role in this area in direct collaboration with national institutions.
[c] In addition to the above, which deals with research topics, it is assumed that ISNAR would play a role in relation to supporting strategy of research and management for many of the above institutions.

ANNEX VI

INSTITUTIONAL OPTIONS FOR FORESTRY AND AGROFORESTRY

OPTION A
TAC'S RECOMMENDED INTEGRATED FORESTRY/AGROFORESTRY OPTION

This is a "clean slate" approach (i.e. without taking ICRAF into account). It is intended to illustrate the type of integrated centre that could most adequately cover the range of forestry/and agriculture related (agroforestry) issues set out by the Bellagio Task Force within the framework of CGIAR goals and TAC's earlier illustrative assessment of the sort of research topics that would most benefit from centralization and CGIAR support.

It considers the possibility of building up the research capability of CGIAr centres (particularly CIAT, IITA, ILCA, ICRISAT and ICARDA), the possible role of specialized research institutes to contribute to CGIAR research goals, and the recommendation of TAC 52 that around 70 percent of CG support for forestry should be directed to the regions and about 30 percent to centralized activities. The centre would carry out strategic research. Its outposted regional staff would be directly involved in assisting national institutions to design and implemnent research programmes.

The assessment of scientific disciplines and staff numbers are a forward look at what such a centre might need five to ten years from now (at full development). A gradual build up to this staffing level would occur.

As a starting point for discussion, this integrated centre might be built around four major research and two support programmes with the approximate central scientific discipline and professional staff requirements as follows:

Programme 1 - Agroforestry (See Annex IV, Table 1)

This programme would cover:

- Agroforestry and land use systems
- Component interactions in agroforestry systems

TAC's RMFA Panel assessment of the likely range of scientific expertise needed for the above topics covered the following main disciplines: sociology, economics, geography, agrometeorology, agronomy, forestry, horticulture, soil science, physiology, entomology, pathology, taxonomy, biochemistry, animal science.

It was assumed that additional inputs to this agroforestry programme would come from staff located in the MPT improvement, agroforestry/forestry policy, and scientific support services programmes discussed below.

The Panel's assessment of likely scientific research needs for this programme was a total of 10 for headquarters scientific research and a further 25 outposted regional staff to support the work of the IARCs/NARs/NFRs and specialized research centres.

Programme 2 - Woody germplasm collection and multipurpose tree species improvement (See Annex IV, Tables 2 and 3)

Under this heading would be included global woody species germplasm collection and exploration, germplasm characterization, seed production and germplasm conservation, MPTS species and provenance selection, MPTS evaluation and description, MPTS genetic improvement. In relation to the first three of these topics, there would be strong collaborative linkages with IBPGR, which is planning an expansion of its own work in this area.

Under this programme, which would cater to the similar centralized strategic research needs of both agroforestry and forestry species, the following range of disciplines would be required: genetics, plant breeding, seed biology, physiology, silviculture, soil microbiology, entomology, botany, pathology, taxonomy, social science, economics, biochemistry, forest products.

Allowing for shared services with other research programmes (particularly social sciences and research support services) the TAC/RMFA Panel's assessment of research scientist needs was 10 for the centre's core research programme and a further 10 outposted staff to support regional research operations.

Programme 3 - Natural forest management and silviculture (See Annex IV, Tables 4 - 7)

This programme would be particularly concerned with the management and regeneration of natural forests, woodlands and forest plantations; reclamation of degraded forests (with special emphasis on saline and acid soils); restoration of fertility in forest fallows; management of fast growing compensatory species for fuelwood, industrial and other uses for planting either as infarm woodlots on agricultural wasteland and/or in large scale plantations.

The range of scientific disciplines needed adequately to cover this topic would include: silviculture, taxonomy, biochemistry, hydrology, soil nutrition, and soil microbiology.

Taking into account the possibility of common shared scientific input in the areas of soil science, plant physiology, entomology, pathology, genetic and economics from Programmes 1, 2 and 4, the Panel envisaged a total of 5 scientific staff in post for headquarters research and 10 outposted regional staff.

Programme 4 - Socioeconomics and policy research (Annex IV, Table 8)

Under this programme, there would be two main areas of activity:

- Macroeconomic policy research aimed particularly at improved understanding of the underlying causes of deforestation and remedial policies. This would be largely contractual research with specialized policy researchers and would complement IFPRI's activities in this area.

- Socioeconomics and policy research at the farm/village/encroached forest level, with special reference to improved understanding of people's perceptions of the usefulness of trees, their role in sustainable land use and agriculture, potential to contribute to rural incomes, and incentive policies for encouraging people's support in natural forest management and tree planting/growing programmes. This would build on ICRAF's D&D methodology and experience by encouraging its wider adoption by both NARs and NFRs in the various regions, and for use in encroached forest lands and in forests where indigenous people's livelihood depends on multiple end use management of forests.

A combination of sociology, economics, land tenure expertise would form the core staff of such a group, with strong input from a Scientific Support Services programme in the area of statistics, biometrics, computer modelling, and input as appropriate from technical scientific staff in the other research programmes listed above.

The RMFA Panel's assessment was that a total scientific headquarters staff of five would be needed for this programme, with a further 10 outposted to regional/national research institutions or IARC's. (This latter number allows for an early input into agroforestry farming systems research in regions other than Africa.)

Programme 5. Scientific support services

This support programme would cover the following main areas:

- Statistical support for design and analysis of experiments and surveys
- Programmeming and modelling
- Soil and plant analysis
- Geographic information systems
- Cartographic and photographic services
- Database development and management

Staff needs in this area cover expertise in statistics, computer modelling, geographic information systems and land use capability interpretation, and data analysis. A total of five professional staff is envisaged.

Programme 6. Information and training

This would cover the range of specialized training staff needed to support the above programmes. A total of 5 staff is envisaged.

Senior Administrative Staff

Assumed as 5 senior staff (Director General, Assistant DG, Programme/Budget, Planning and Finance)

Table 1 summarizes the staff required for the TAC recommended option.

Annex VI

Table 1. Scientific staff required for TAC's recommended integrated option A

Research Programme	Scientific Staff		Total
	Head-quarters	Out-posted[a]	
Agroforestry	10	25	35
Germplasm collection/evaluation, MPT selection and improvement	10	10	20
Natural forest management/silviculture	5	10	15
Agroforestry/forestry policy	5	10	15
Scientific support staff	5	--	5
Information/training	5	--	5
Administration	5	--	5
TOTAL	45	55	100

[a] This assumes an input from the centre for simultaneous support to strategic/applied agroforestry research in all major geographic regions.

Likely costs of the recommended integrated Option "A"

Assuming that this centre were to be created from scratch (i.e. not building on ICRAF), the capital, building and equipment costs might be in the order of US$20 million. Annual operating costs on the basis of an estimated cost of US$250,000 per international staff member (to cover associated support services staff and facilities) would amount to about US$11 million for headquarters strategic research. An additional US$14 million for outposted regional staff would give a total annual operating cost of US$25 million.

OPTION B
SEPARATE AGROFORESTRY AND FORESTRY RESEARCH CENTRE

This option is based on the assumption that ICRAF would be incorporated into the CGIAR system virtually as is, and that its research agenda and staff structure would be as laid out in the "Strategy to 2000" paper with projected staff at 1995 levels.

A separate CGIAR forestry research centre would be created to deal primarily with issues of forestry and land use restricted to forest ecosystems.

The TAC/RMFA Panel met with ICRAF representatives between August 23-25 1990 to discuss ICRAF's definition of the boundaries between forestry and agroforestry (see Annex VIII for details).

(a) Agroforestry land use systems

ICRAF regards the following as agroforestry land use systems/technologies:

Mainly agrosilvicultural (trees with crops)

Rotational
- Shifting cultivation
- Improved tree fallow
- Taungya

Spatial mixed
- Open: Trees on cropland
- Dense: Plantation crop combinations, multistoreyed home gardens

Spatial zoned
- Hedgerow intercropping (alley cropping, barrier hedges)
- Boundary planting
- Windbreaks and shelterbelts
- Trees on erosion-control structures

Mainly or partly silvopastoral (trees with pastures and livestock)

Spatial mixed
- Open: Trees on rangeland or pastures
- Dense: Plantation crops with pastures

Spacial zoned
- Live fences
- Fodder banks

Tree component predominant (see also taungya)

- Woodlots with multipurpose management
- Reclamation forestry leading to multiple use

(b) Forestry land use systems

Forest land use systems are defined (by ICRAF) as ecosystems where the main output is either timber or other non-food/fodder related products. Following from that definitioon forestry research would relate mainly to protection and increasing productivity of natural mainly 'closed' forests and plantations where timber/fuelwood are the main outputs and/or where the forest is protected for watersheds or for conservation of biodiversity.

TAC rejects this arbitrary division of agroforestry/forestry land use systems as a basis for determining institutional mandates.

OPTION 'B' - AGROFORESTRY CENTRE

ICRAF research agenda and staff objective by 1995 is as follows:

Programme 1 - Agroforestry and land use systems

ICRAF envisages that this will remain a small, multidisciplinary group of six professionals with the following range of expertise: land use evaluation, polant science (agriculture, forestry or horticulture), economics, social science and ecology.

Programme 2 - Component interactions in agroforestry systems

This will be ICRAF's largest programme. It is planned to have 11 scientists in post by 1995. The disciplinary mix will consist of agronomy, soil physics/fertility, plant physiology, microclimato9logy, animal science, pest management, forestry, horticulture, economics and sociology.

Programme 3 - Multipurpose tree improvement

Multipurpose Tree Improvement will become a majro new activity for ICRAF in the 1990s. It is intended that the programme will expand from its current level of 3 scientists in 1990 to 11 by the year 2000 (approximately 9 by 1995). The scientific expertise will include tree breeding, silviculture, seed technology, microbiology, botany, tree physiology and data base management. Two scientists will be required in each of breeding and silviculture.

Programme 4 - Natural forest management/silviculture

Currently ICRAF does no research in this area.

Programme 5 - Agroforestry/forest policy research

This will remain ICRAF's smallest research programme but will receive considerable input from senior management and network coordinators. It was envisaged that there would be 3 professionals in post by 1995, covering the fields of institutional management, policy analysis and planning.

Programme 6 - Scientific support service staff

ICRAF envisages 3 professional staff by 1995 covvering the areas of modelloinjg, statistics and data analysis.

Training and Information

19

Management and Administration

12

To summarize ICRAF projected staff requirements by 1995 would be as in Table 2 below.

Table 2. Projected international professional staff allocations at ICRAF, 1990 and 1995

	Current staff structure	Projected staff structure
AFRENA staff	16	35
Regional Office Coordinators	0	1
Research Division	14	32
Training/Information Division	7	19
Director General's Office	1	4
Senior Management	8	8
TOTAL	46*	99

* Included seconded staff and new staff recruited during 1990.

ICRAF's assessment of incremental capital investment needs to 1995 is about US$ 5 million and annual operating costs $ 25 million.

OPTION 'B-1' - FORESTRY RESEARCH CENTRE

Programme 1 - Woody germplasm collection evaluation multipurpose tree improvement

The range of disciplines required would include genetics, plant breeding, seed biology, physiology, silviculture, soil microbiology, entomology, botany, pathology, taxonomy, social science, economics, biochemistry, forest products. The range of species to be worked on would be more oriented to species with industrial end uses.

Estimated staff requirements are 10 headquarters and 10 outposted.

Programme 2 - Natural forest management and silviculture

The range of topics that could benefit from CGIAR support in this area are summarized in Annex IV, Tables 4 - 7. They would require expertise in silviculture, botany, ecology, taxonomy, biochemistry, hydrology, soil nutrition, and soil microbiology. Total staff requirements would be 6 headquarters and 15 outposted.

Programme 3 - Forestry/socioeconomic policy research

This would require expertise in sociology, economics, and land tenure. Headquarters staff requirements would be five and outposted staff, two.

Programme 4 - Scientific support services

This programme would need expertise in statistics, computer modelling, geographic information systems, land use capability interpretation, data analysis. Total staff requirements would be five core and no regional.

Training and information

5

Management

4

To summarize, Table 3. sets out the approximate staff requirements of this independent forestry research centre.

The probable capital costs for the construction of this centre would be in the order of US$15 million. Annual operating costs would be in the order of US$16 million.

Table 3. Staff requirements for an independent forestry research centre.

	Headquarters	Outposted	Total
Woody germplasm collection/evaluation/MPTS improvement	10	10	20
Natural forest management/silviculture	6	15	21
Policy	5	5	10
Support services	5	--	5
Information/training	5	--	5
Management	4	--	4
TOTAL	35	30	65

OPTION "C"
SIMULTANEOUS CREATION OF THREE SEPARATE FORESTRY RESEARCH CENTRES (LOCATED IN ASIA, AFRICA, LATIN AMERICA) WITH AGROFORESTRY HANDLED BY ICRAF

This was one of the five forestry options reviewed in the earlier TAC papers. It was developed in response to the comments received from several of the TAC forestry outreach panel experts who, in commenting on the option of a single international forestry research centre, expressed reservations about the likely effectiveness of such a centre, given the site specific nature of much forestry research.

It was argued that given resource availability, a more effective alternative would be the simultaneous creation of three independent forestry research centres located in Asia, Africa and Latin America, respectively.

The staffing requirements of each of the three regional centres would be approximately as outlined above for the independent forestry research centre described in Option "B", but with regional staff split between the three centres.

Assuming that each of these centres had a similar staff structure (a total of about 45 professional staff in each, of which 35 would be headquarters and 10 outposted within the region), overall staffing requirements for this option would be about 135.

Capital investment costs for the simultaneous construction of three independent centres would be in the order of a total of US$45 million. Annual operating costs for each of the three centres would in the order of US$11 million, i.e. total for the whole CG system of approximately US$33 million a year.

Under this option, assuming that both ICRAF and these three separate regional FRC's were simultaneously to be incorporated into the CGIAR system, total annual operating costs would be in the order of US$25 million a year for ICRAF and US$33 million a year for the three separate forestry research centres, implying a total requirement of US$58 million a year.

OPTION "D"
A REGIONAL AGROECOLOGICAL RESEARCH CENTRES (RARCs) OPTION

A variation on the three stand-alone forestry research centres option would be to incorporate both forestry and agroforestry research into geographically-defined international centres with agroecological zone responsibility (RARCs).

This option builds on an emerging perception that effective, CGIAR-supported natural resource management research will require significant modifications to the CGIAR's traditional mode of operation.

Historically, the CGIAR has relied on the spin-off from a commodity approach to manage soil and water. It has clearly been inadequate. The shifting cultivation problem, for example, will patently not be solved through a commodity approach.

The recent review by TAC of natural resource concerns and research priorities, and the review carried out at the nonassociated centres, have highlighted the agroecological and site specific nature of many research needs, and has led to reappraisal of the CGIAR's current structure.

One of the various options currently under consideration is creation of ecoregional research centres which, inter alia, might have functions along the following lines:

- Assess the strengths and weaknesses of the natural resource base to be studied. Problem identification and analysis will be a major responsibility.
- Determination of which problems or constraints need international research.

- Determination of which problems or constraints require long-term trials which must be established on a site under the control of the centre or its closest and most reliable collaborators.
- Carrying out of soil, land, water and forestry research in the zone.
- Collaboration with commodity germplasm centres to define specific crop problems in the zone and to understand pest and disease dynamics for those crops.
- Establish collaborative research networks to carry out research on the most important problems.

To undertake such functions effectively would demand a multidisciplinary systems approach to resource management research (RMR) beyond the scope of the CG's traditional commodity programmes, to give special reference to the interaction between cultural circumstances, economic opportunities and technical possibilities, and the subordination of commodities and their management to the needs of the system.

Applying this model to forestry and agroforestry has some obvious attractions. However, developing a clear picture of the likely staffing needs, costs and effectiveness of such an approach is difficult at this point in time because (a) the model would obviously require significant restructuring of the CG system and is unlikely to be in place in less than three to five years; (b) the model fits better in some situations (particularly those regions where there are very weak NARs) than in others; (c) without further study, it is difficult to be precise about the number of centres that would be needed to cover effectively resource management, forestry and agroforestry research needs.

For the purpose of this preliminary illustration, the assumption has been made that three such centres would be created (one each in Asia, Africa, Latin America).

The scientific staff needs for integrated regional forestry/agroforestry research within these centres would be approximately along the following lines.

Programme 1 - Agroforestry

As for Option A above. Expertise would be required in the areas of sociology, economics, geography, agrometeorology, agronomy, forestry, horticulture, soil science, physiology, entomology, pathology, taxonomy, biochemistry, animal science.

Estimated staff required are 15 per centre.

Programme 2 - Multipurpose tree improvement

The range of disciplines required would include genetics, plant breeding, seed biology, physiology, silviculture, soil microbiology, entomology, botany, pathology, taxonomy, social science, economics, biochemistry, forest products.

Estimated staff requirements are 13 per centre.

Programme 3 - Natural forest management and silviculture

This would require expertise in silviculture, economic botany, taxonomy, biochemistry, hydrology, soil nutrition, fire control, soil microbiology and zoology. Total staff requirements would be 12 per centre.

Programme 4 - Agroforestry/forestry socioeconomic policy research

This would require expertise in sociology, economics, and land tenure.

Core staff requirements would be five per centre.

Programme 5 - Scientific support services

This programme would need expertise in statistics, computer modelling, geographic information systems, land use capability interpretation, data analysis.

Total staff requirements would be five per centre.

Table 4. summarizes the approximate forestry/agroforestry staff requirements of the Regional Agroecological Research Centres.

Table 4. Forestry/agroforestry staff requirements for a Regional Agroecological Research Centre

Research Thrust	Scientific Staff per Centre
Agroforestry	15
MPTS	13
Natural forestry management/silviculture	12
Policy	5
Support services	5
Information/training	3
Management	2
TOTAL	55

Assuming that these centres would be incorporated into existing CGIAR centres (such as CIAT, IITA, ICRISAT and ICARDA), the incremental capital costs to cover the needs of forestry and agroforestry might be in the order of US$15 million and annual operating costs (for all three centres), a total of US$40 million. In practice, significant savings in scientific staff needs might be achieved by sharing some existing areas of expertise already in post in the IARCs.

OPTION "E"
A GLOBAL FORESTRY RESEARCH CENTRE INVOLVED IN NO HANDS ON RESEARCH WITH AGROFORESTRY CONTINUING TO BE HANDLED BY ICRAF

This model, which was one of five options in the earlier TAC analysis, was based on the past experience of the IUFRO/SPDC. The Centre would primarily act as a "broker" and facilitator for creation of regional networks, and a central training and data base point for forestry research. The Centre would provide a mechanism for channeling and coordinating international financial and technical support to forestry research in developing countries. It would not have any hands-on research function. There would be strong emphasis on improving research capability and capacity through information systems development, technical and management training programmes and other support activities.

Based on the preliminary cost estimates prepared by the Bellagio Task Force, a very modest headquarters staff of five was envisaged, plus 12 outposted regional coordinators.

The annual costs of this centre would be about US$5 million a year. If this proposal were to be adopted by the CGIAR, all regional research programmes would be executed under contractual arrangements. The Bellagio Task Force suggested that the cost of these might be in the order of US$50 million by 1991. (For the purpose of this paper, it has been arbitrarily assumed that US$25 million would be for agroforestry and US$25 million for forestry research. Initial capital costs for this option would be minimal since it was assumed that office staff space would be rented).

ANNEX VII

BUDGETARY IMPLICATIONS OF TAC's RECOMMENDED OPTION "A"

The budgetary implications below relate only to the TAC recommended integrated Option "A". The following were the main underlying assumptions used in approaching this topic.

Setting a realistic target for forestry/agroforestry research

An exercise based on the assumption of an unconstrained resource situation would be unrealistic. As a starting point for this exercise, the panel used three main criteria:

(a) An assessment of the likely regional budgetary research needs as developed in Parts I and II of this paper, taking into account likely absorptive capacity constraints at the national level and the weak status of many NFRS.

(b) Consideration of how much forestry/agroforestry research might reasonably expect to secure as a share of the overall CGIAR funding requirements.

(c) Estimates of likely incremental forestry research needs for an internationally-supported tropical forestry/agroforestry research programme as estimated by the Bellagio Task Force (which suggested US$20 million in 1990 rising to about US$50 million by 1995. This would be incremental to the estimated current level of US$45-50 million in official development assistance (ODA) to forestry research provided by multilateral and bilateral donor and technical assistance agencies. The new total would bring ODA for research up to about 9% of total ODA for forestry and related fields. This still would be below the percentage going to research in the case of agricultural ODA.

Regional vs. centralized research

The recommendation of TAC 51 that about 70% of CGIAR funding for forestry/agroforestry should be directed towards the regions and about 30% to centralized research was adopted as a guideline for allocating funding between regional/national and global activity.

Likely forestry/agroforestry oriented activities of existing CGIAR centres

The assumption was made that forestry/agroforestry related research carried out by ICRISAT, ILCA, IITA, CIAT, ICARDA, IBPGR, IFPRI and ISNAR would be incorporated as integral components of the budgets of those centres. TAC made a preliminary assessment of the possible staffing needs of those Centres for forestry/agroforestry related research.

Recommended CGIAR support to existing "specialized forestry/agroforestry research institutes" that could play a key role in supporting research networking and other activities in the regions

As noted in the text, several long established research institutes (e.g. CSIRO, NFTA, OFI, CTFT, CATIE, ITF, etc.) have over many years built up productive programmes with national forestry and agricultural reseach institutions. Taking into account the weak institutional capability of many national forestry research institutions, and the fact that under the ecoregion research model, it would take a considerable time to build up regional forestry research capability in existing CGIAR centres, these specialized centres could play a critical role as a source of strategic research input, scientific support for design and monitoring of implementation of national research trials, provision of catalytic funding, support for research seminars, training workshops and so on.

To ensure a sustained input to key areas of research priority of interest to the CGIAR System, TAC recommended a modest level of CGIAR support to selected specialized institutes, under contractual arrangements.

Based on the above assumptions the total CGIAR support for forestry/agroforestry research would be in the order of US$41 million of which about US$12 million would be for centralized global research and $29 million for regional research. That latter figure includes the cost of outposted staff from the central forestry/agroforestry institute.

Table 1 summarizes the likely cost distribution of CGIAR-supported forestry/agroforestry research by 1995.

Annex VII

Table 1. Likely cost of CGIAR-supported forestry/agroforestry research programme by 1995 (US$ million)

INSTITUTIONS	GLOBAL	ASIA	AFRICA	LAC	WANA	TOTAL
A. Regional						
ICRISAT		1.2	1.3			2.5
IITA			2.0			2.0
ILCA			1.5			1.5
CIAT				1.5		1.5
ICARDA					0.5	0.5
Sub-Total		1.2	4.8	1.5	0.5	8.0
B. Global						
The centralized forestry/agroforestry research centre	11.0	6.0	3.0	3.0	2.0	25.0
IBPGR	0.5					0.5
IFPRI	0.5					0.5
ISNAR	0.5					0.5
Sub-Total	12.5	6.0	3.0	3.0	2.0	26.5
C. Contracted research with specialized institutes in support of regional research activities (illustrative only)						
CSIRO, CTFT, OFI, ITTO		2.5	2.5	1.5		6.5
Sub-Total		2.5	2.5	1.5		6.5
GRAND TOTAL	12.5	9.7	10.3	6.0	2.5	41.0

ANNEX VIII

MEETING BETWEEN REPRESENTATIVES OF TAC AND ICRAF MANAGEMENT AND BOARD TO DISCUSS ICRAF'S VIEWS ON THE TAC FORESTRY/AGROFORESTRY RECOMMENDATIONS[1]

A. General Ideas Projected by ICRAF

The idea of a continuum makes sense in terms of problems of development and what has to be done on the ground in land-use management. But it is not an appropriate concept on which to builda research institution because of the different research approaches required in different parts of the continuum. Research can more easily be structured on the basis of ecosystems, both natural and man-made.

There is a need to distinguish clearly between agroforestry as a discipline and what is actually done on the ground in land-use systems.

There will be a continuing need for an entity to look at the issues lying between agriculture and forestry. In this respect the image of agroforestry and the name of the institute that promotes it are vital to forging creative linkages and catalyzing activities.

B. Some Concerns Expressed by ICRAF

ICRAF already has a large agenda and is having to make difficult choices between competing demands. It might be swamped by forestry and risk losing its focus both geographically and technically. A merger with forestry might drive agroforestry more towards working on woody ecosystems and weaken ICRAF's links with agriculture.

ICRAF is concerned that the proposal to merge forestry and agroforestry into a single institutional structure was based on an attempt to change attitudes which could be better changed through education and training. There is a general desire to "break down walls" between forestry and agriculture. The creation of a combined centre might, in reality, serve to create new walls.

ICRAF's research agenda is firmly based on its networking approach with national programmemes. Its strategic research is designed to respond to the needs identified through applied and adaptive research in national programmemes. ICRAF is concerned that both these principles might be under threat in a combined institutional structure.

ICRAF's View on a Separate Forestry Institute

ICRAF believes that a strong case could be made for a separate forestry institute based on the management of natural forests to make them more profitable and sustainable. It should start small and evolve. Much of the research needs to be decentralized because of location specificity but methodology, etc. could be developed centrally. Such an institute would appeal to donors. Development funds are available for tropical forestry some of which might be tapped for research. Without such an institute foresters would consider they had been short-changed.

ICRAF's Views on the Paper for ICW 90

There should be much more stress in the paper on evolution, both in programmemes and in structure.

The number of options presented for consideration by the CGIAR should be kept to a minimum. Ones that are unlikely to be viable should either be excluded or reduced in prominence.

TAC's reasons for combining forestry and agroforestry should be more clearly spelt out.

The management problems of a combined institute of the size projected should be recognized and discussed.

C. ICRAF Views Concerning Areas of Research in the TAC Recommended Agenda That Would and Would not Fit Within the ICRAF Mandate

ICRAF is prepared to change to undertake a considerable amount of the work suggested in the TAC paper. For example, given additional resources it would consider accelerating expansion of its programmemes into regions other than Africa.

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[1] The meeting with ICRAF was on 23 August 1990. Further discussions took place 24-25 August at the meeting of the full TAC Resource Management, Forestry and Agroforestry Panel. This meeting also was attended by the ICRAF Board Chair and its Director General. The latter pointed out that the views expressed at the meetings by the Board Chair and himself did not represent an agreed upon position of the Management and Board of ICRAF, since the members had not yet had an opportunity to read and formally react to TAC's written materials.

In terms of research substance, the Panel and ICRAF Management discussed the extent to which research areas in the TAC recommended agenda would or would not fit logically within a broadened ICRAF mandate acceptable to the Director General of ICRAF. Using as a base for discussion the programme areas recommended by TAC, the following conclusions were reached:

Programme 1 - Agroforestry

This programme would build on the major research thrusts identified in ICRAF's "Strategy to 2000" paper, i.e.:

- Agroforestry and land use systems
- Component interactions in agroforestry systems

Both of the above fit within ICRAF's current mandate.

TAC's RMFA Panel assessment of the likely range of scientific expertise needed for the first two of the above topics by 1995 covered the following main disciplines: sociology, economics, geography, agrometeorology, agronomy, forestry, horticulture, soil science, physiology, entomology, pathology, taxonomy, biochemistry, animal science.

It was assumed that additional inputs to this programme would come from staff located in the MPT improvement, agroforestry/forestry policy, and scientific support services programmes discussed below.

Programme 2 - Woody germplasm collection and multipurpose tree species improvement

Under this heading would be included global woody species germplasm collection and exploration, germplasm characterization, seed production and germplasm conservation, MPTS species and provenance selection, MPTS evaluation and description, MPTS genetic improvement. In relation to the first three of these topics, there would be strong collaborative linkages with IBPGR, which is planning an expansion of its own work in this area.

This programme would cater to the very similar centralized strategic research needs of both agroforestry and forestry species. Thus, much of the work involved would fit within the mandate of ICRAF. (Exceptions are noted below).

The following range of disciplines would be required: genetics, plant breeding, seed biology, physiology, silviculture, soil microbiology, entomology, botany, pathology, taxonomy, social science, economics, biochemistry, forest products.

Programme 3 - Forest management and silviculture

This programme would be particularly concerned with the management and regeneration of natural forests, woodlands and forest plantations; reclamation of degraded forests (with special emphasis on saline and acid soils); restoration of fertility in forest fallows; management of fast growing compensatory species for fuelwood, industrial and other uses.

Of the above, the activities in forest areas which involve a combination of food production and production of multiple forest products fit within the mandate of ICRAF. This applies, for example, to large parts of the savanna woodland areas of Africa. It also applies to the encroached natural forests of the tropics, which contain upward to 200 million slash and burn agriculturists. Thus, a major portion of the natural forests in the world could benefit from research inputs which fit within the scope of ICRAF's mandate. In fact, an integrated agriculture/agroforestry/forestry research thrust is essential for making progress in easing the negative effects of deforestation on local populations and in building more sustainable land use systems.

The range of scientific disciplines needed to cover adequately this topic includes: silviculture, agronomy, sociology, economic botany, taxonomy, biochemistry, hydrology, soil nutrition, fire control, soil microbiology and zoology.

Programme 4 - Socioeconomic and policy research

Under this programme, there would be two main areas of activity:

- Macroeconomic policy research aimed particularly at improved understanding of the underlying causes of deforestation and remedial policies. This would be largely contractual research with specialized policy researchers and would complement IFPRI's activities in this area.

- Socioeconomic and policy research at the farm/village/ encroached forest level, with special reference to improved understanding of people's perceptions of the usefulness of trees, their role in sustainable land use and agriculture, and their potential to contribute to rural incomes; and incentive policies for encouraging people's support in natural forest management and tree planting/growing programmes. This would build on ICRAF's D&D methodology and experience by encouraging its wider adoption by both NARs and NFRs in the various regions, and for use in encroached forest lands and in forests where indigenous people's livelihood depends on multiple end use management of forests.

Much of the envisioned policy and socioeconomic research fits within ICRAF's mandate.

A combination of sociology, economics, anthropology, land tenure expertise would form the core staff of such a group, with strong input from a scientific support services programme in the area of statistics, biometrics, computer modelling, and input as appropriate from technical scientific staff in the other research programmes listed above.

The main conclusions from the above analysis are:

(i) A majority of the research topics envisioned in the TAC recommended research agenda could be accommodated within ICRAF's Mandate.

(ii) Many of the scientific disciplines required for the TAC recommended integrated centre option are already incorporated into ICRAF's already planned staff structure.

(iii) The main areas of divergence between TAC's recommended agenda and ICRAF's mandate, i.e., the forestry research topics that fit within the CG mandate but that are unacceptable to ICRAF, relate to the following illustrative topics:

(a) Global Thrusts

Management and regeneration of natural forests, with special reference to increasing the productivity of secondary (logged over) forests in situations where the main objectives of management relate either to long rotation species for timber/pulp/panel production or to management of forest ecosystems for protection of soil and water resources (i.e., in situations where food/fodder/and minor forest products are not the main end uses.).

Establishment and management of plantation forests for long rotation, commercial/industrial timber production (i.e., where food production, including grazing and woodlot planting for income generation, are not the main management objectives).

Genetic improvement of tree species which are primarily suited to longer term, single purpose plantation timber/pulp/wood-based panel production.

(b) Regional Research Topics

Asia:

- Management of natural forests
- Standardized methods for biological research (e.g., gap studies) that could lead to less damaging harvesting systems for the tropical rainforest.
- Data handling methods of uneven aged poly-specific forests;
- Growth and yield modelling.
- Autecological studies of the behavior of component species.

Africa:

- Management and regeneration of natural forests:
  (a) humid, wet tropics,
  (b) arid and semi-arid zone, dry forest
- In the wet zone, standardized methods for biological research (e.g. gap studies) that could lead to less damaging harvesting systems for the tropical rainforest.
- Data handling methods for uneven aged poly-specific forest.
- Growth, yield and modeling studies under alternative management regimes, e.g., further testing of silvicultural techniques being applied by CTFT in the Yapo Forest.
- Autecological studies of the behavior of component species.

Annex VIII

Latin America and the Caribbean

- Natural forest management with special reference to increasing productivity of secondary (i.e. logged over or degraded) forest land. (Building on the work of CATIE, ITF, OTS and STRI).
- Standardized methods for biological research (gap studies) that could lead to less damaging harvesting systems for the tropical rainforest.
- Data handling methods for uneven aged poly-specific forests.
- Autecological studies of the behavior of component species.

Participants at the Meeting:

TAC
M.H. Arnold, Chair
G. Budowski
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ICRAF
B. Lundgren
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Donor Representatives
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K. Venderryn (USAID)

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J. Palmer

CGIAR Secretariat
J. Spears

TAC Secretariat
E. Craswell

ANNEX IX

DOCUMENTS USED IN THE ASSESSMENT OF THE NON-ASSOCIATED CENTRES AND REVIEW OF FORESTRY

1. Banana and Plantain

Report of the TAC Fact-Finding Mission to the International Network for the Improvement of Banana and Plantain (INIBAP). TAC Secretariat, May 1989.

Report of the TAC Panel on Banana and Plantain Research. TAC Secretariat, March 1990.

Role of the CGIAR in Banana and Plantain Research. Desk Analysis. TAC Secretariat, April 1990.

2. Coconut

Coconut Research: An International Initiative. Consultant's Report prepared for TAC. June 1988.

Coconut: International Research Priorities. Consultant's Report prepared for TAC. September 1989.

Coconut Research Opportunities. Discussion Paper prepared for TAC 52 Meeting, IITA, Ibadan, Nigeria. June 1990. G.J. Persley, ACIAR, Canberra, Australia.

The Coconut Palm: Prosperity or Poverty. G.J. Persley. June 1990. ACIAR, Canberra, Australia.

Role of the CGIAR in Coconut Research. Report of the TAC Panel on Coconut. TAC Secretariat, June 1990.

3. Crop Protection

Report of the TAC Fact-Finding Mission to the International Centre of Insect Physiology and Ecology (ICIPE). TAC Secretariat, May 1989.

Evaluation of Crop Protection Research, Training and Technology Transfer at the International Agricultural Research Centres. David R. Mackenzie, Study Director. Report submitted to TAC, September 1989.

Report of the Review Team for the Third External Periodic Review of the International Centre of Insect Physiology and Ecology (ICIPE). Nairobi, March 1990.

Report of the Task Force on Integrated Pest Management. ACIAR, March 1990.

Report of the TAC Panel on Crop Protection Research. TAC Secretariat, April 1990.

Role of the CGIAR in Crop Protection Research. Desk Analysis. TAC Secretariat, May 1990.

4. Fisheries

Development of New CGIAR Initiatives: Aquaculture Research. (AGR/TAC:IAR/87/28 Rev. 1). C.P. Idyll, 1988.

Report of the TAC Fact-Finding Mission to the International Centre for Living Aquatic Resources (ICLARM). TAC Secretariat, June 1989.

Possibilities for CGIAR Support to Fish Production Research. Report of the TAC Ad Hoc Working Group on Aquaculture. TAC Secretariat, August 1989.

Review of Developments in Aquaculture. COFI/89/Inf.5. FAO, Rome, 1989.

Draft Report of the Study on International Fisheries Research, undertaken on behalf of the World Bank, FAO, UNDP, CEC and twelve bilateral donor agencies. World Bank. February 1990.

Report of the TAC Panel on Fisheries Research. TAC Secretariat, May 1990.

Role of the CGIAR in Fisheries Research. Desk Analysis. TAC Secretariat, June 1990.

5. Forestry and Agroforestry

Report of an International Task Force on Forestry Research. A Global Research Strategy for Tropical Forestry. September 1988.

Report of the TAC Fact-Finding Mission to the International Council for Research in Agro-Forestry (ICRAF). TAC Secretariat, May 1989.

International and Regional Organizations and Networks Involved in Tropical Forestry Research: A Stock Taking Report of the TAC Panel on Forestry. TAC Secretariat, June 1989.

The IUFRO Special Programme for Developing Countries (SPDC): A Stock Taking. Report of the TAC Ad Hoc Panel on Tropical Forestry Research. TAC Secretariat, June 1989.

Priority Forestry Research Areas with Potential for International Centralization. Report of the TAC Panel on Forestry. TAC Secretariat, August 1989.

Assessment of the Capacity of the IUFRO/SPDC to Meet CGIAR Objectives in Forestry Research. Report of the TAC Panel on Forestry. TAC Secretariat, November 1989.

Developing Institutional Options for Forestry in the CG System: A Suggested Process. Report of the TAC Panel on Forestry. TAC Secretariat, November 1989.

Report of the TAC Panel on Forestry Research. TAC Secretariat, March 1990.

Report of the TAC Panel on Agroforestry Research. TAC Secretariat, March 1990.

Institutional Options for Entry of Forestry into the CG System. Report of the TAC Panel on Forestry. TAC Secretariat, March 1990.

A Suggested Institutional Approach to Incorporation on Forestry and Agroforestry into the CGIAR System. CGIAR/TAC Secretariat, April 1990.

Strategy and Institutional Options for Forestry and Agroforestry in the CGIAR System. Report of the TAC Panel on Resource Management, Forestry and Agroforestry. TAC Secretariat, August 1990.

6. Livestock Diseases in Sub-Saharan Africa

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ANNEX X

LIST OF ACRONYMS

AARINENA	Association of Agricultural Research Institutions in the Near East and North Africa
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
ASEAN-COFAF	Association of Southeast Asian Nations - Committee on Food, Agriculture and Forestry
AVRDC	Asian Vegetable Research and Development Centre
BUROTROP	Bureau for the Development of Research in Tropical Perennial Oil Crops
BIFAD	Bureau for International Food and Agriculture Development
CABI	Commonwealth Agricultural Bureau International
CABO	Centre for Agrobiological Research
CARDI	Caribbean Agricultural Research and Development Institute
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CORAF	Conférence des Responsables de Recherche Agronomique Africains
CRIDA	Central Research Institute for Dryland Agriculture
CRSP	Cooperative Research Support Programme
CRTA	Centre de Recherches sur les Trypanosomes Animales
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTFT	Centre Technique Forestier Tropical
DANIDA	Danish International Development Agency

EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
FAO	Food and Agricultural Organization of the United Nations
F/FRED	Forestry/Fuelwood Research and Development Project
FINNIDA	Finnish International Development Agency
FHIA	Fundación Hondureña de Investigación Agricola
FRC	Forestry Research Centre
FRIM	Forest Research Institute of Malaysia
GATT	General Agreement on Tariffs and Trade
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IAEA	International Atomic Energy Agency
IBPGR	International Board for Plant Genetic Resources
IBSNAT	International Benchmark Sites Network for Agrotechnology Transfer
IBSRAM	International Board for Soil Research and Management
ICARDA	International Centre for Agricultural Research in Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICIPE	International Centre of Insect Physiology and Ecology
ICLARM	International Centre for Living Aquatic Resource Management
ICRAF	International Council for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDB	Inter-American Development Bank
IDRC	International Development Research Centre
IFDC	International Fertilizer Development Centre
IFPRI	International Food Policy Research Institute
IIMI	International Irrigation Management Institute
IITA	International Institute for Tropical Agriculture
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases

INIBAP	International Network for the Improvement of Banana and Plantain
IRFA	Institut de Recherche sur les Fruits et Agrumes
IRHO	Institut de Recherche pour les Hulles et Oleagineux
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
ITC	International Trypanotolerance Centre
ITF	Institute Tropical Forestry
ITTO	International Timber Trade Organization
ITFFR	International Task Force on Forestry Research
IUCN	International Union for the Conservation of Nature and Natural Resources
IUFRO/ SPDC	International Union of Forestry Research Organization/ Special Programme for Developing Countries
KU	Katholieke Universiteit (Leuven)
NACA	Network of Aquaculture Centres in Asia and the Pacific
NFTA	Nitrogen Fixing Tree Association
ODA	Overseas Development Administration
OFI	Oxford Forestry Institute
PROC-IANDINO	Programa Cooperativo de Investigacion Agricola para la Subregion Andina
PROCISUR	Programa Cooperativo de Investigacion Agricola para la Region Sur
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SADCC	Southern Africa Development Coordination Conference
SEAFDEC	Southeast Asia Fisheries Development Centre
SIDA	Swedish International Development Agency
TAC	Technical Advisory Committee to the CGIAR
TFAP	Tropical Forestry Action Plan
TROP-SOILS	Tropical Soils Programme of Cornell and North Carolina State Universities and the University of Hawaii

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	Untied Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
WARDA	West Africa Rice Development Association
WHO	World Health Organization

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

PROPOSED EXPANSION OF THE CGIAR SYSTEM

Extract from "Summary of Proceedings and Decisions"

International Centres Week 1990

Washington DC, USA, 29 October - 2 November 1990

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Background

TAC's report on "A Possible Expansion of the CGIAR" was the centrepiece of discussion at ICW'90, requiring far-reaching decisions that could affect the future scope and structure of the CGIAR System. The report was presented to ICW'90 by TAC Chairman Alec McCalla.

The report was the result of a two-year deliberative process which began when the Group decided at its 1988 mid-term meeting to seek advice from TAC on the desirability of admitting all or some of 10 non-associated centres into the CGIAR.

Donor subsequently expressed the view at the Group's 1989 mid-term meeting that the mandate of the CGIAR should be expanded to include agroforestry/forestry research.

In responding to the Group's requirements, Mr. McCalla pointed out, TAC had re-examined the fundamental objectives of the CGIAR both in the present and in the future, and reviewed the potential of the 10 non-associated centres in relation to those goals.

Based on that analytical and deliberative process, TAC presented ICW'90 with proposals for integrating forestry/agroforestry in the CGIAR System, a major expansion of the System, substantial restructuring of the System in the medium term, and for the long-term evolution of the System.

Process

In keeping with the significance and complexity of TAC's proposals, the Group spent some 20 hours of ICW'90 on the TAC report, both in plenary and executive session.

The Group followed a step-by-step procedure in which the information to be dealt with was disaggregated, and discussion moved back and forth between specific detail and the broad picture.

Discussions were held under the following main headings:

- Background to the TAC report and the process by which conclusions were reached;

- Long- and medium-term visions of the CGIAR;
- Analysis and recommendation on non-associated centres;
- Integration of forestry/agroforestry;
- Structural and resource implications;
- Decisions and next steps.

This pattern of deliberation enabled the Group to look ahead at the long-term scenario as conceptualized by TAC, to focus on specific recommendations, to return to a review of the broader picture, and to reach decisions based on both the broader picture and the implications of specific recommendations.

The Chairman pointed out how the deliberative process followed at ICW'90 ensured that decisions reached by the Group were based on the broadest possible exchange of views - including dissent from TAC's views. There was no question of the Group being treated as a "rubber stamp agency". Donors expressed their appreciation of the consensual process that was followed.

Systemic Restructuring

Mr. McCalla reminded the Group that the TAC report was based on a process of examination which was both exhaustive and transparent. The Group had been consulted at each stage of the examination, and the next stage embarked upon with the Group's prior approval.

Furthermore, although TAC had been asked to review 10 non-associated centres for their possible inclusion within the System, the committee felt that it could not approach the task as a simple matter of recommending inclusion or exclusion.

TAC saw the potential expansion of the CGIAR as the starting point for institutional and programmatic restructuring. The basis of the changes proposed was an integrated approach which would apply to all aspects of the CGIAR, whether it be commodity research, the broad spectrum of natural resource management, or the agroforestry/forestry sector.

In keeping with these principles, TAC had reviewed the goal statement of the CGIAR, in an effort to determine whether the statement should be revised in the light of changed and changing circumstances in the international environment.

At its last iteration in 1986, the CGIAR goal statement read as follows: "Through international agricultural research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of low income people are improved."

TAC proposed, Mr. McCalla said, that the emphasis on "increasing sustainable food **production**" should change to an emphasis on food **self reliance** in the developing regions of the world. "Food self reliance" was defined as the capacity of a nation to provide a sufficient stable food supply to all of its inhabitants, either from domestic production or from the production of exportable goods to enable commercial imports to cover the domestic deficit.

TAC had gone on to develop the following mission statement for the CGIAR: "Through international research and related activities, and in partnership with national research systems, to contribute to sustainable improvements in the productivity of agriculture, forestry and fisheries in developing countries in ways that enhance nutrition and well-being, especially among low-income people."

This central mission required the following nine goals or priority areas for action: effective management and conservation of natural resources; improved productivity of important crops and their integration into sustainable production systems; improved productivity of important livestock and their integration into sustainable production systems; improved production of important trees and their integration into sustainable production systems; improved productivity of important fish and their integration into sustainable production systems; improved utilization of agricultural, forestry and fish products in both rural and urban areas through improved post-harvest technology; improved diets, family welfare and equity (including gender equity) through better understanding of the human linkages between production and consumption; appropriate policies for increased productivity in agriculture, food, fisheries and forestry and for the sustainable use of natural resources; and strengthened institutions and human resources in national research systems to accelerate the identification, generation, adaptation and utilization of technological innovations.

As a corollary to defining CGIAR goals, TAC developed a medium- and long-term vision for the evolution of the System. In the medium term, research supported by the CGIAR would fall into two clusters: global commodity activities and ecoregional activities. Each of these clusters was explicitly defined and described in the TAC report.

- **Global** activities would be focussed on commodities and selected subject matter areas, such as policy, management, conservation of germplasm and the maintenance of biodiversity.

- **Ecoregional** activities would focus on applied and strategic research on the ecological foundations of sustainable production systems, commodity improvement in collaboration with global commodity activities and interaction with national partners.

Over the long term, the CGIAR would be a smaller, service oriented enterprise and much less of a hands-on applied research System. When that stage was reached, more work would be undertaken by national research systems.

In the context of that analysis, TAC made separate recommendations on each of the non-associated centres it was asked to review.

As part of its review, TAC attempted to assess the financial implications of proposed courses of action, and suggested an immediate increase of some 10 percent in funding requirements, followed by a reduction of that increase. There will be something of a bulge in the System, as and when it takes on new responsibilities. The bulge will be flattened as the System is restructured, and it is assumed that funding requirements will drop back to current levels.

The implications of the TAC report, as they affected the future philosophy of the CGIAR and as they suggested the extent to which the CGIAR should be expanded, were examined from several different perspectives. The main comments made by participants fell into several broad categories.

Endorsement: The transparency of the process which TAC had gone through, as well as the strong analytical base on which the Group's decisions could be anchored, were strongly endorsed. Mr. McCalla, members of TAC, the TAC and CGIAR Secretariats, as well as others who had participated in the process were commended. The report's comprehensive approach to complex issues was considered exemplary, and the guidance it provided was an important contribution to the development of the CGIAR over both the short and long term. The conceptual thrust of the report was similarly endorsed.

Natural resource management: TAC's analyses concerning the relationship between natural resource management and agricultural productivity were considered compelling. The recommendation that CGIAR centres should undertake ecoregional activities was welcomed. This approach could create the sustainability/productivity construct which would ensure the System's continued effectiveness and relevance. Some concerns were expressed, however, that there was an inconsistency between the analytical emphasis on natural resource management and individual recommendations regarding some non-associated centres whose programmes were particularly oriented towards research connected with natural resources.

National research systems: TAC's interest in strengthening national agricultural research systems in developing countries was appreciated, but some delegates felt that the relationship between national systems and the CGIAR required further elaboration. The appropriate division between upstream and downstream research formed part of the discussion. Several participants emphasized the view that the task of strengthening national systems could not be looked upon as of secondary importance, because without strong national systems CGIAR centres could not have impact in developing countries. Continued efforts to strengthen national systems and gradually to pass on more activities to them were urged. This relationship would probably elicit additional funding from bilateral "envelopes", in the view of some donors.

Innovation: The suggestion was made that a greater sense of innovation within the CGIAR would enhance support for the System. Whether it was in relations with national systems, or in the kinds of research undertaken, greater innovation and creativity would help to attract funds that were available but would not be directed toward supporting traditional CGIAR programmes.

Research themes: As the CGIAR moved towards restructuring itself and redefining its priorities, the elaboration of broad themes, particularly in the natural resource management area, could give clarity to future discussions. Themes could be related to institutions, including non-associated centres, and would provide the basis on which the expansion issue could be revisited after ICW'90.

Resources: The point was made by several delegates that principles and programmes could not be separated from the financial resources available to undertake expansion, restructuring, or any other activity within the System. TAC's financial estimates for the medium- and long-term future were attractive, but the financial picture had to be assessed in terms of actual availability not just of estimates.

Agroforestry/Forestry

The consideration of agroforestry/forestry issues within the CGIAR derived from the Group's Declaration of Intent which drew attention to "the evident and urgent need to investigate the significant research issues of natural resource management for sustained food production and for the long-term maintenance of lands best suited to tropical and sub-tropical forests".

The Declaration also stated the Group's desire to widen its mandate "to include research on the optimal management of tropical and sub-tropical forest lands giving particular stress to the interaction of agriculture and forestry, and the use of forest resources as an important contributor to the rural economies, energy needs, and the wealth of partner nations".

Following on that Declaration, and taking into account the priority research areas outlined at the Bellagio conferences which provided to the CGIAR's exploration of the agroforestry/forestry question, TAC mounted an exhaustive series of consultations with lead agencies in the field such as FAO, other groups, and individuals.

At the culmination of the process, TAC recommended an integrated agroforestry/forestry approach, and a decentralized programme under which some 70 percent of resources would go to regional and national research in agroforestry/forestry and 30 percent to centralized activity.

TAC proposed that the centralized activity should be entrusted to ICRAF, if its Board and Management were willing to revise its mandate to encompass an integrated agroforestry, change its name and prepare in consultation with TAC the plans and programmes that would be subject to normal CGIAR procedures. If ICRAF could not make those changes, TAC proposed the establishment of a new, integrated agroforestry/forestry centre.

Participants at ICW'90 reaffirmed their desire that CGIAR-supported research should be broadened to include agroforestry/forestry as part of natural resource management.

Most of them had already made a conceptual commitment to this aspect of expansion. Others said their governments had made a financial commitment in principle as well, but were awaiting the emergency of mechanisms which could be funded. The urgency of going ahead with agroforestry/forestry research was emphasized.

TAC's view that forestry and agroforestry should be regarded as a continuum was generally supported. The recommendation that the CGIAR should support a decentralized programme was also endorsed.

However, given a recent decision by ICRAF's Board that it did not wish to take on additional responsibilities for forestry and its rejection of TAC's suggested conditions for entry of ICRAF into the CGIAR System, the debate centered on alternative centralized mechanisms for forestry.

During the Executive Session of donors a consensus emerged that a CGIAR programme of work in forestry and agroforestry will most likely require two "entities" functioning in close collaboration with each other and with other stakeholders, including national and international institutions active in this area.

The specific mandates of these two entities, and the division of labour between them, should be complementary, providing a coherent and efficient approach to global agroforestry/forestry research.

The Group agreed that one of these entities should be ICRAF, with its mandate and strategy modified in terms of its relationship with the other "entity". The mandate and the scope of work of the second entity should be defined between now and the next meeting of the CGIAR.

Main Decisions

Clear consensus emerged from the discussion of the TAC report on the importance of natural resource management as a twin pillar of CGIAR-supported research. The other pillar would continue to be productivity. Based on that broad view:

- The Group strongly endorsed the concept of ecoregional activity within the CGIAR System as a means of merging productivity concerns with natural resource management, and asked for a further TAC report elaborating on the nature of these activities and the mechanisms by which they would be undertaken;

- The Group urged that in elaborating on the concept of ecoregional activity, TAC should examine a series of natural resource management themes - such as the soil/water relationship, soil fertility, plant protection, etc. - and advise the Group on institutional changes required to ensure that those themes were encompassed in CGIAR-supported research; and

- The Group sought clarity and specificity on the funds that would be required at each stage of the System's envisaged expansion.

Responding to TAC's analysis of the subject matter areas covered by the 10 non-associated centres reviewed, and to TAC's centre-by-centre recommendations, the Group decided by consensus as follows:

AGROFORESTRY/FORESTRY

Two entities will be admitted into the System: ICRAF, appropriately modified, and a new institution.

A Working Group consisting of Australia (Mr. George Rothschild), Brazil (Mr. Manoel Malheiros-Tourinho), IDRC (Mr. Geoff Hawtin), the Rockefeller Foundation (Mr. Bob Herdt) and Sweden (Mr. Bo Bengtsson) was established to develop proposals for the second institution. The Working Group was expected to report to the CGIAR mid-term meeting in May 1991 on:

(a) the spectrum of research to be undertaken by the new entity;

(b) the design of an institutional mechanism;

(c) options for location and staffing; and

(d) the relationship between the new entity and ICRAF.

The Working Group should build on the work of TAC, work closely with ICRAF and consult with the CGIAR members and other key actors as necessary. The Working Group was asked to agree on its own organization and work procedures and to keep the CGIAR informed of its progress.

AVRDC

The consensus of the Group was that vegetables research should be an important constituent element of the work of the System, and the global contribution made by AVRDC to vegetables research was recognized without dissent. At the same time, however, the Group as well as TAC appreciated the need for political developments to mature before final decisions could be taken. The Chairman will contribute towards a resolution of issues when he visits China next March.

COCONUTS

Issues relating to coconut research will be taken up as part of the attempt to settle questions concerning agroforestry/forestry research.

IBSRAM/IFDC

The Group agreed that it was unable at the present time to invite IBSRAM and IFDC to join the System. The themes of the soil/water relationship and of soil fertility are important aspects of natural resource management, and are linked with ecoregional considerations as outlined by TAC. Consequently, the CGIAR will revisit the role IBSRAM and IFDC could play in the System, following elaboration and discussion of a TAC paper on ecoregional activities.

ICIPE

The TAC recommendation was for ICIPE to remain outside the CGIAR and the consensus of the Group is to accept the recommendation. The issue will be revisited in the context of plant protection as a theme related to ecoregional mechanisms of the future.

ICLARM

The CGIAR endorses the TAC recommendation to incorporate fisheries research in the work supported by the Group. It also endorses TAC's request that ICLARM should develop a strategic plan, and that external reviews should thereafter be mounted by TAC and the CGIAR Secretariat. The CGIAR will consider admission of ICLARM upon completion of the external reviews.

IIMI

Recognizing the importance of soil/water and plant protection relationships to resource management research, and drawing the distinction with irrigation management research, the TAC recommendation was for unconditional entry of IIMI. The consensus of the Group is to accept the TAC recommendation.

INIBAP

The TAC recommendation was for INIBAP to be incorporated into IITA but to retain its identity. The consensus of the Group is to include INIBAP in the CGIAR as an independent network and monitor its performance as an innovative operational mode. INIBAP and IITA in collaboration with TAC will work out a sharing of responsibilities and the details of their collaboration.

ITC

The TAC recommendation was that the CGIAR should await the results of the African Livestock Study led by Winrock International before taking a decision on ITC. The consensus of the Group is to accept the recommendation.

Summation

Summing up the process which began with a broad review of options and ended with specific decisions, the Chairman emphasized that the conclusions reached were inseparable from the intensive discussions which preceded them.

The final decision-making session was relatively swift and short, but there was no suggestion of their deliberations on a possible expansion of the System representing a rushed-through operation. Prompt decisions were possible at the end only because of their searching debate at the beginning.

Paying tribute to TAC, the Chairman pointed out that the committee had presented the Group with a truly outstanding analytical base. Members of the Group differed from TAC on various details. That was unavoidable and not undesirable. Pallid uniformity can be a sign of weakness.

Because the Group had the advantage of a report characterized by vision, analytical depth, and integrity, it was possible for the Group to position itself after several days of sometimes passionate and always earnest discussion on the restructuring of the System and on the themes that underpin the changes proposed.

Eventually, the Group was called upon to take specific decisions on individual non-associated centres. But those decisions were based on a solid conceptual foundation involving acceptance of the need for broad changes in the CGIAR. They should thus be clearly seen in terms of their systemic significance and not a piecemeal responses to separate recommendations.